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OCTOBER 1956
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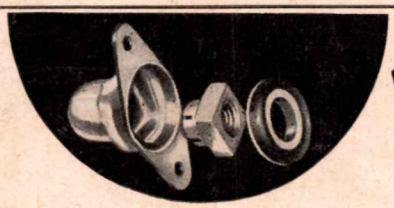
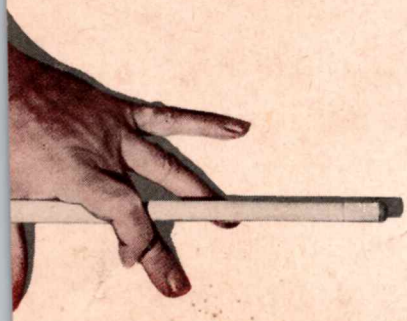
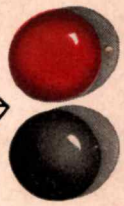
MILITARY PROCUREMENT ISSUE





one good thing leads to another



The two products shown here are made
and sold by two famous names in American industry—
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By adding a sealing design by the Franklin C. Wolfe Company
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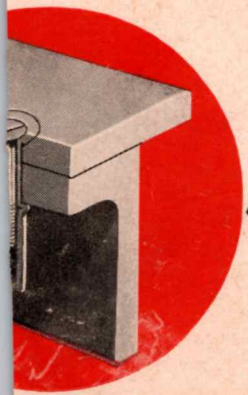

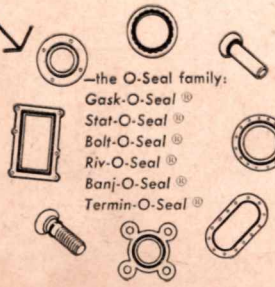

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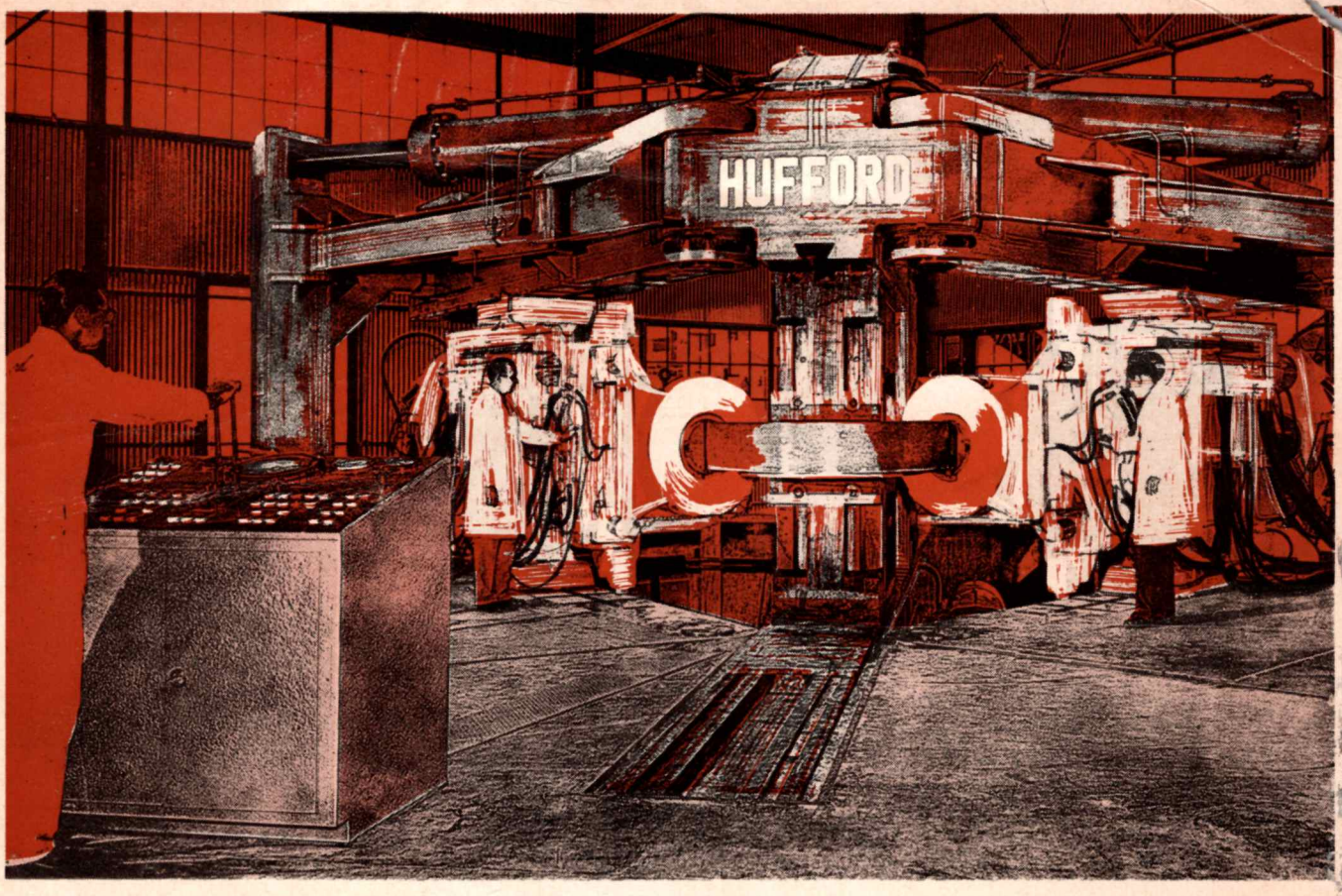
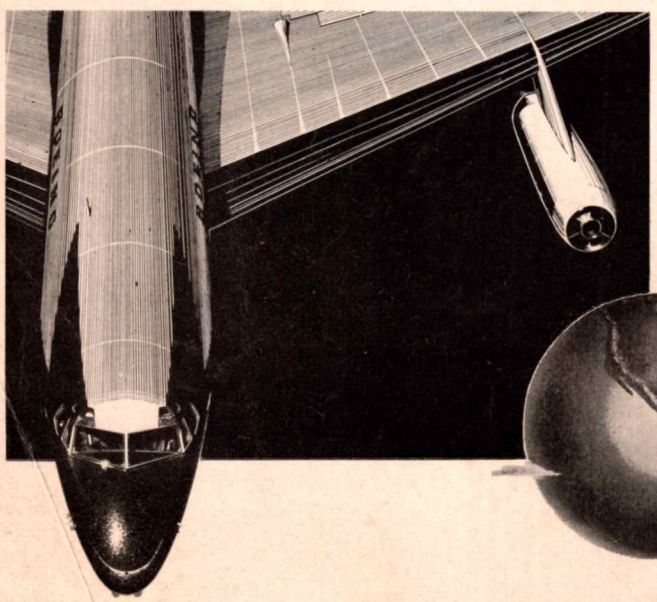


350-TON HUFFORD STRETCH FORMER — PART OF ROHR'S MULTI-MILLION DOLLAR TOOL KIT

This giant Rohr machine is one of the two largest of its kind in the world. It permits the forming of an increasing variety of large size stringers, stiffeners, skins and fillet fairings . . . it makes possible the forming of deep outsized contoured parts considerably beyond the capacity of standard stretch machines and conventional presses.

Today, with this and hundreds of other heavy manufacturing machines, Rohr produces over 30,000 different parts for aircraft of all types. This is, of course, in addition to Rohr's being recognized as the world's largest producer of ready-to-install power packages for airplanes.

For design and engineering know-how, for full production facilities look to Rohr to build more into the aircraft parts you need.



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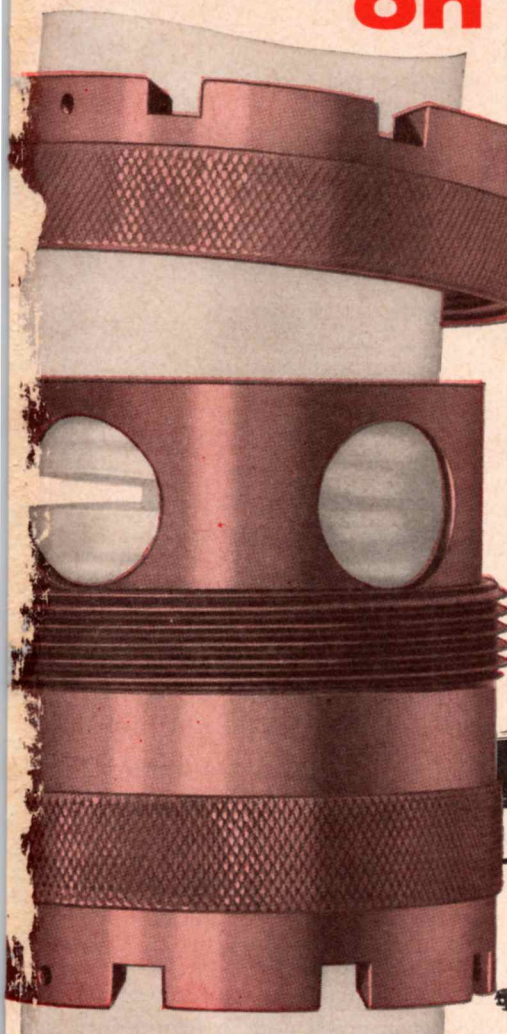
WIG-O-FLEX® couplings save 46 pounds on North American F-100c



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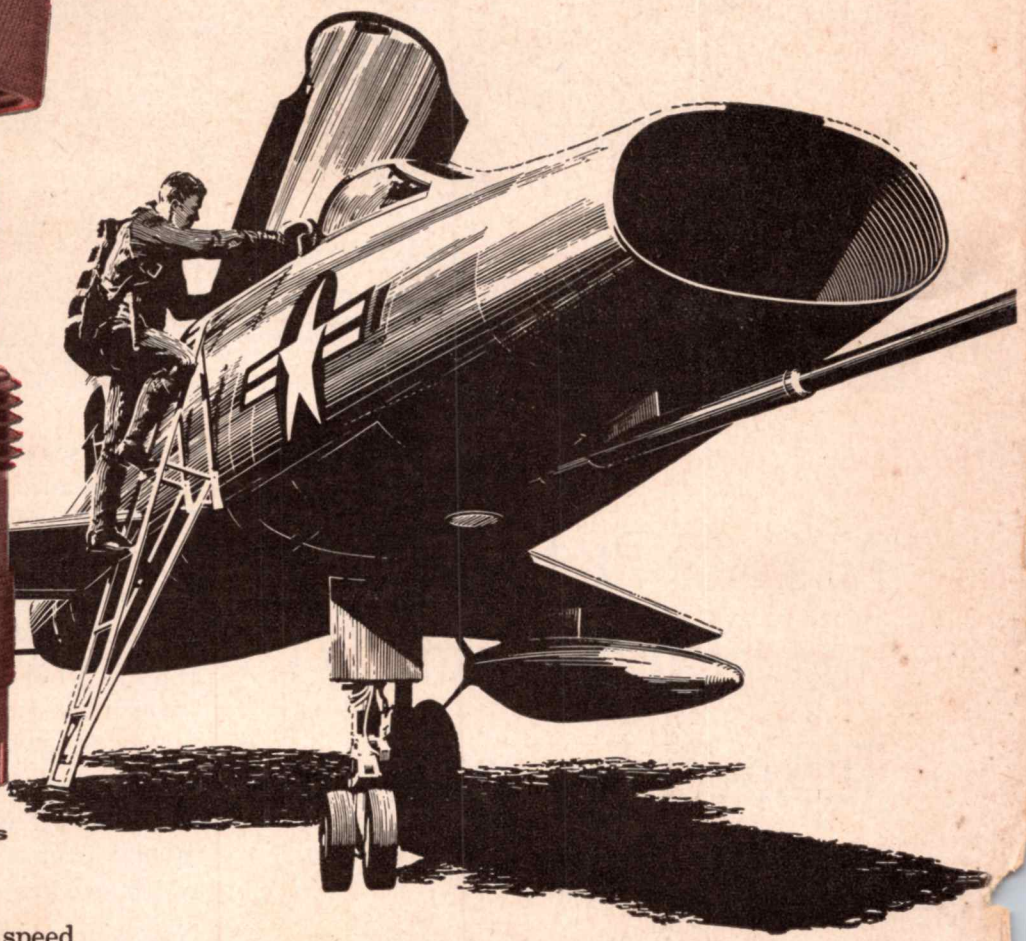

THE WORLD'S FIRST supersonic speed record holder—the North American F-100C SUPER SABRE—is 46 pounds lighter because WIG-O-FLEX Couplings replaced standard AN connections and cut hose. G-O-FLEX Couplings weigh 1/5 as much as standard AN connections they can replace. *Write for further information.*

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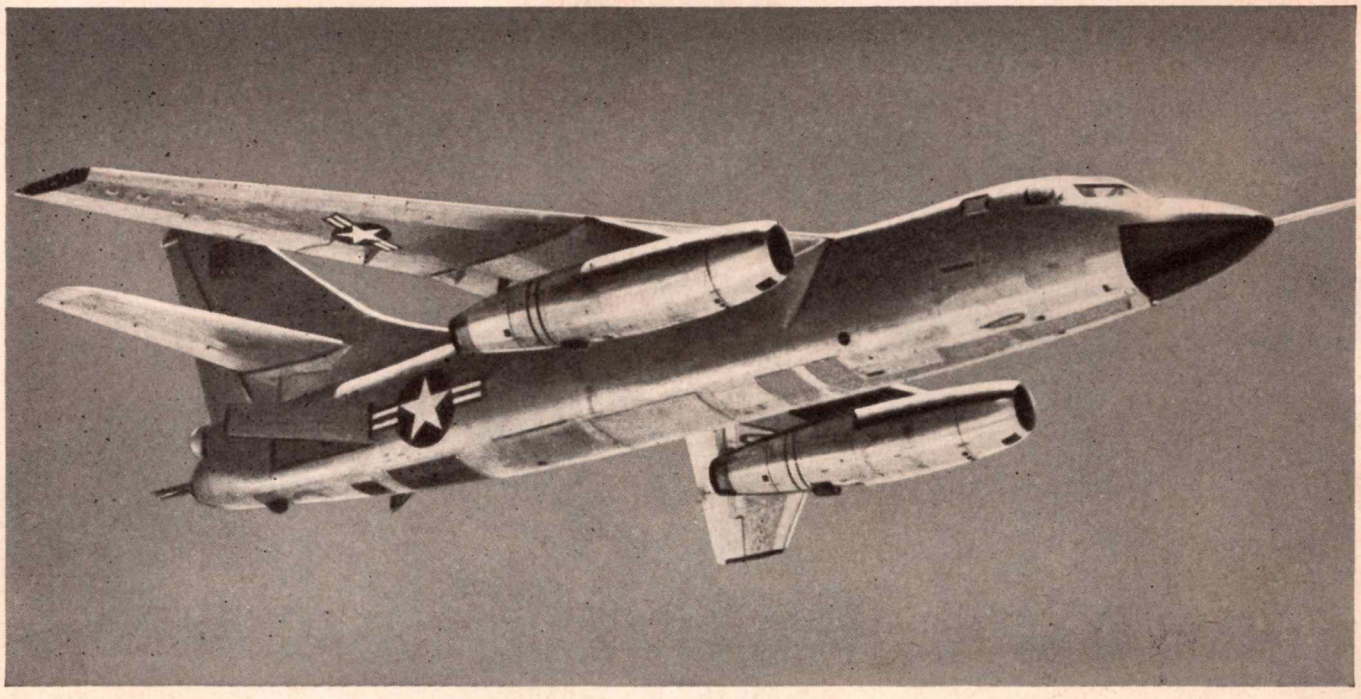
"EYES" FOR THE AIR FORCE TACTICAL AIR COMMAND



Air Force RB-66 powered by Allison J71 Turbo-Jet Engines

Here you see the Tactical Air Command's newest reconnaissance bomber—the all-weather twin-jet Douglas RB-66.

It carries a payload of nuclear or conventional bombs—which it can wing at 600-700 mph to targets dictated by the nation's needs.

It packs a full complement of camera equipment —which also makes it a valuable reconnaissance tool for air intelligence.

And in pods under its wings it boasts a pair of Allison J71 Turbo-Jet engines – each producing 10,000 pounds' thrust without augmentation – which take it to altitudes over 40,000 feet.

Now winning its wings for reliability and dependability with the 363rd Tactical Reconnaissance Wing at Shaw Air Force Base, S. C., the Allison-powered RB-66 carries a three-man crew as it goes on its peace-maintaining missions.

The Allison-powered Douglas RB-66 is another example of how continuous engine development —both Turbo-Jet and Turbo-Prop—is helping keep America first in the air.

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AVIATION ENGINEERING

PUBLISHED BY THE AERONAUTICAL DIGEST PUBLISHING CORPORATION

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AVIATION ENGINEERING

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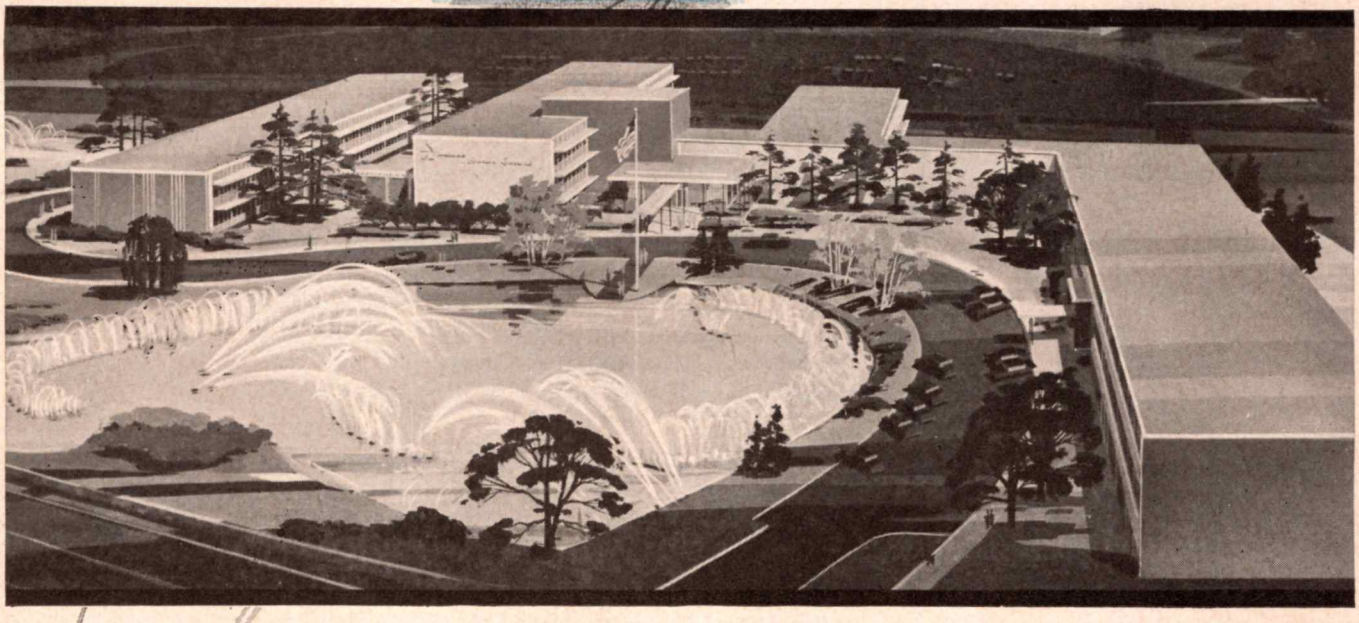
a Campus way of life for creative engineers



Here at McDonnell Aircraft Corporation aeronautical engineering history is being made by our new "Engineering Campus." The architect's rendering of this 16-acre development adjoining our plant gives an idea better than any words of the great steps being taken at McDonnell to provide its engineers with a new kind of work environment for creative thinking and effective achievement.

The development's imaginative scope, colorful beauty and detailed attention to working comfort are attracting nationwide attention as a logically ultimate answer to a vital need of the aircraft industry. One building is completed and occupied, and a second is already under construction. The entire group upon completion at a cost of more than $6,000,000 will comprise integrated facilities of, by and for engineers.

This latest chapter in McDonnell's record of pioneering achievements is another significant indication why the company in only 17 years has grown from two individuals to a team of more than 17,000 persons. We are now working on a backlog of orders for fighters, missiles and helicopters that exceeded two-thirds of a billion dollars on June 30.

Newest McDonnell planes in production for national security are the versatile F3H-2N Demon, fastest all-weather fighter in the Navy, and three different versions of the world's most powerful fighter, the supersonic F-101 Voodoo, for the Air Force. Work is in progress on four advanced missiles, including Talos.

We salute the engineers who have done so much to make possible our contributions to the nation's airpower. We believe a good part of the accomplishments stems from a fundamental policy that takes into account the highly individual capacities and aspirations of able and productive men. The "Engineering Campus" program is our direct-action pledge to our engineers—those now at McDonnell and those who will join them—that we are determined to maintain and develop further an environment that fosters the sort of creative achievements on which continued progress depends.

Professional and economic advancement await qualified engineers at McDonnell Aircraft. We provide free in-plant engineering courses taught by our own top engineers and sponsor graduate and undergraduate programs at the two outstanding universities in St. Louis. We invite you to investigate joining our team of the ablest minds in aeronautics — united in making fundamental progress in advanced airplanes, helicopters and guided missiles—by writing to R. F. Kaletta, Technical Placement Supervisor.

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aero news digest

News In Brief

Britain's largest air transport, the 100-foot-long Blackburn Beverly, first British aircraft designed especially for dropping heavy military equipment by parachute.

Retractable Falson carried in Scorpion wing-tip pods.

PROJECT VANGUARD: Most recent reading on the cost of the IGY satellite program, at first price-tagged at $10-million and later at $30-million, shows its projected cost reaching up and past $50-million. Word is that nobody would be complaining even at this figure if accelerated progress could be seen—but reports indicate that powerplant troubles among others might keep the IGY satellites earthbound past the IGY deadline.

AFL-CIO: As a "friend of the court," the National Society of Professional Engineers has asked the U.S. District Court for the District of Columbia to rule that the Taft-Hartley Act gives professional engineers the right to a separate election in de-certification proceedings. If the present NLRB decision stands, then some 22 engineer-employees of Westinghouse at Jersey City,N. J., now represented for collective bargaining by the electrical workers union, AFL-CIO, will be unable to decide for themselves whether they want to continue the representation.

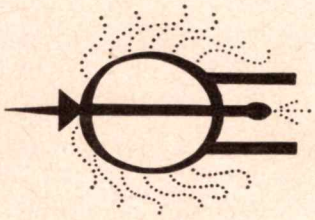
PAY BOOST: In a further move to meet competition from private industry, the Federal Government will pay higher starting salaries to certain aeronautical research engineers, chemists and physicists. The new starting rates will be the same as the present top salary rate for the grade in each instance. Present employees below the new rates will also receive the benefits. The changes are: GS-9, from $6115 to $6250; GS-11, from $7035 to $7465; GS-12, from $7570 to $8645; GS-13, from $8990 to $10,065; GS-14, from $10,320 to $11,395; GS-15, from $11,610 to $12,690; GS-16, from $12,900 to $13,760; and GS-17, from $13,975 to $14,835. About 30 categories of aeronautical research engineers are affected. Initial recruiting needs at the new rates are estimated at 200.

NUCLEAR PROPULSION: Additional facilities for use in the U.S. Air Force's Aircraft Nuclear Propulsion Program are available through a recent contract between the USAF and the AEC. The contract makes the nuclear shielding facility at the AEC's Brookhaven National Laboratory, New York, available for a long-term research program. This ARDC program is headed by Dr. Robert Schamberger, former chief of the Brookhaven Shielding Group.

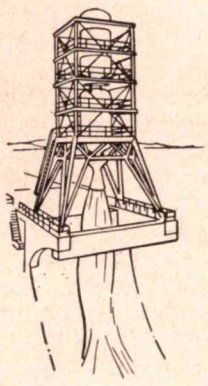
Vanguard Progress Lagging

Optimists working on the U. S. satellite project say it should be airborne next spring, April at the latest. Time table includes firing of the Viking 13 by Martin, Baltimore, in November, and firing the Viking 14 in January. These are the guinea pigs for the ultimate, satellite-bearing Vanguard vehicle.

SOLID ENGINE AND CHEMICAL DIVISION



Dependable, simple—the solid-propellant rocket is unique in America's arsenal. Its power is instantaneously unleashed, its performance unaffected by atmosphere and actually improved by altitude. Aerojet-General's jet-assisted takeoff units (JATOs) are the world's most widely used auxiliary power-plants for aircraft.



In the search for new materials of construction, new fuels, and higher thrusts, Aerojet-General offers unequalled opportunity in America's most comprehensive rocket propulsion program.

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Pessimists on Vanguard report that a peck of bugs will have to be killed off to keep the time table dates. It has been known for some time that powerplant troubles have dogged the Vanguard scientists. Now comes exclusive word to AERO DIGEST that the vehicle may suffer from structural buckling and twisting and that the nose cone offers additional problems. Hope is to eliminate some of these difficulties in the Viking 13, knock them all out in the 14. But the consensus is that it will not be easy, and if the calendar catches up with the Vanguard scientists, the program may have to be put on a super-crash basis early in the new year.

News Censorship Increases

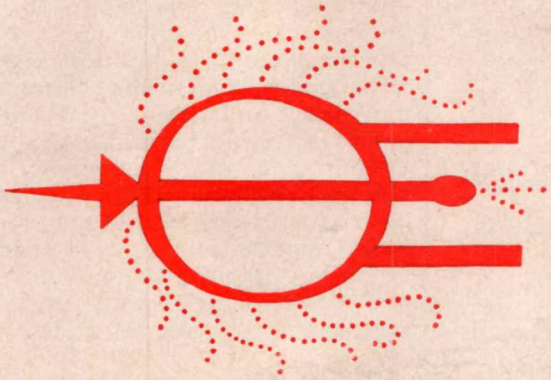
All of the above is still top secret at the Pentagon, where a new crackdown in news leaks is now in operation, complete with recorders in the offices of some officers suspected of talking too much. Irked by repeated leaks, Defense Secretary Charles Wilson has appointed a committee to study ways of plugging them. Clearance of stories, never fast in recent months, has slowed to a snail's pace. An article was returned the other day after a six-week tour of the Pentagon, during which we are told it touched all bases, including the office of the Joint Chiefs of Staff. Censored passages were few, but censors were numerous enough to man a regiment. Worse, many engineers and scientists working on defense projects, especially if they are concerned with aviation, are refusing to talk even among themselves. Typical result is that NACA research into boundary-layer control is still largely under blankets, although parallel findings from abroad are readily available. Why Pentagon brass doesn't wake up to the fact that they are damaging the defense effort by studying ways of blocking the news flow, instead of vice versa, will continue to be one of Washington's outstanding mysteries.

Vanguard Nosecone Hits Snag

Getting back to Project Vanguard, a glimpse of the difficulties was revealed the other day by George F. Metcalf, General Electric general manager of special defense projects. He points out that the development of a nose cone which can withstand meteoric flight conditions is one of the most baffling problems facing scientists today. "The tremendous magnitude of this task is emphasized by the fact that relatively little knowledge exists today in the new fields of aerothermodynamics, aeroballistics, hypersonics and other fields. This means that the frontiers of science in physics, chemistry, metallurgy, electronics and other basic sciences must be expanded." General Electric alone," he adds, has "well over several hundred top research scientists and engineers" at work on special defense projects. Nosecone research and development at G-E is going forward as part of a prime contract with the Air Force Air Research and Development Command.

Small Businesses Get Congressional Support

Another kettle of boiling water for Pentagon executives is brewing in the Congress, following hear-



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er-Rammah's self-moving egg

Join two flat pans; fill with an incendiary mixture; add a tail; propel by two large rockets. In A.D. 1280, Arabia's Hassan er-Rammah, gazing centuries ahead, proposed this ovoid in his "The Book of Fighting on Horseback and with War Engines."

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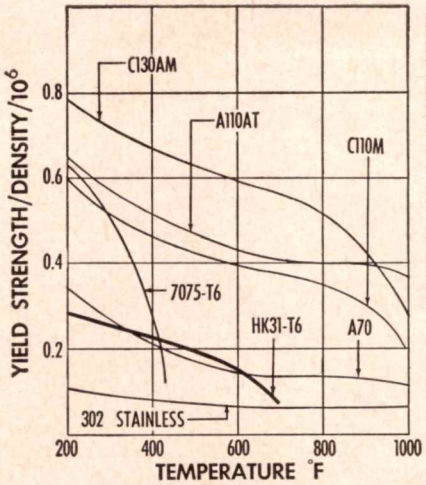

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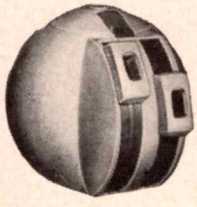
Magnesium turret enclosure for a bomber. Design, lofting, prototypes, production fabrication and assembly are all done by B&P.

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ings last spring on procurement practices and the small businessman. The hearings were held before a Senate small business subcommittee on government procurement. Chairman of the subcommittee was Florida Senator George A. Smathers. He and his colleagues concluded that while top Pentagon brass give "well-meaning" lip service to Congressional directives that the small businessman get his share of defense contracts, actually he runs into trouble because Pentagon practices are "woefully short of proper implementation at the operational level." Points out the Smathers group: "The very small businessman with his ten employes, turning out various machined or fabricated components, stops far short of the generals, the admirals and the assistant secretaries in his quest for defense contracts. It is the contracting and purchasing people and the technicians developing the requirements with whom he comes in contact, and these are the people who must be made aware of the incalculable contribution which can be made to our defense program by the small, independent firms throughout the nation." These statements were made by the subcommittee early in April, but complaints continue to pour in, according to spokesmen of the Smathers group. They propose to crack down on Pentagon procurement personnel at the working level if immediate improvements are not made.

U. S. Aircraft Production Upped In Face of Soviet Threat

Headlines regardless, the visit to Russia of USAF Chief of Staff General Nathan F. Twining and his staff of experts revealed that, generally, the U.S. are more than holding their own in the air defense cold war. Plane for plane, we are equal to or better than the Soviets. With the readjustment resulting from the trip, our production will be stepped up to rival theirs. Lieut. Gen. Donald Putt, deputy chief of staff for research and development, reports that Russian aircraft development is "about three years behind us." The USAF B-52 "looks even better than I thought" contrasted with the Russian Bison, reports General Twining. Russian production in this department is ahead of ours, but an increase in production here will offset the Soviet lead. Our F-104 fighter, says Lieut. Gen. C. S. Irvine, deputy chief of staff for materiel, "is better than anything we saw." The Soviet transonic bomber Blow Torch looks good today, but "I am sure our B-58 will be much better. We are doing all right in other departments." Says General Irvine: "Nothing we saw was any different or any better than what we are doing. I think that in detailed engine design, those things which give you range, they are still behind us. In the fundamental fields of electronics and metallurgy the Russians are as good, possibly better, than we are, but they are not as good as we are in production engineering."

We should not be lulled into complacency by these findings, the generals warn. Obviously the Russians, once considered a minor rival in the air, are now a powerful challenger to the U.S. In one vital field, they are building toward a stronger future than we can anticipate unless drastic changes are made here. This is manpower. The Russians are training scientists, engineers and technicians at a rate far beyond ours, and the results are already showing. General Putt was "astounded at the number of air force officers that they (the Russians)

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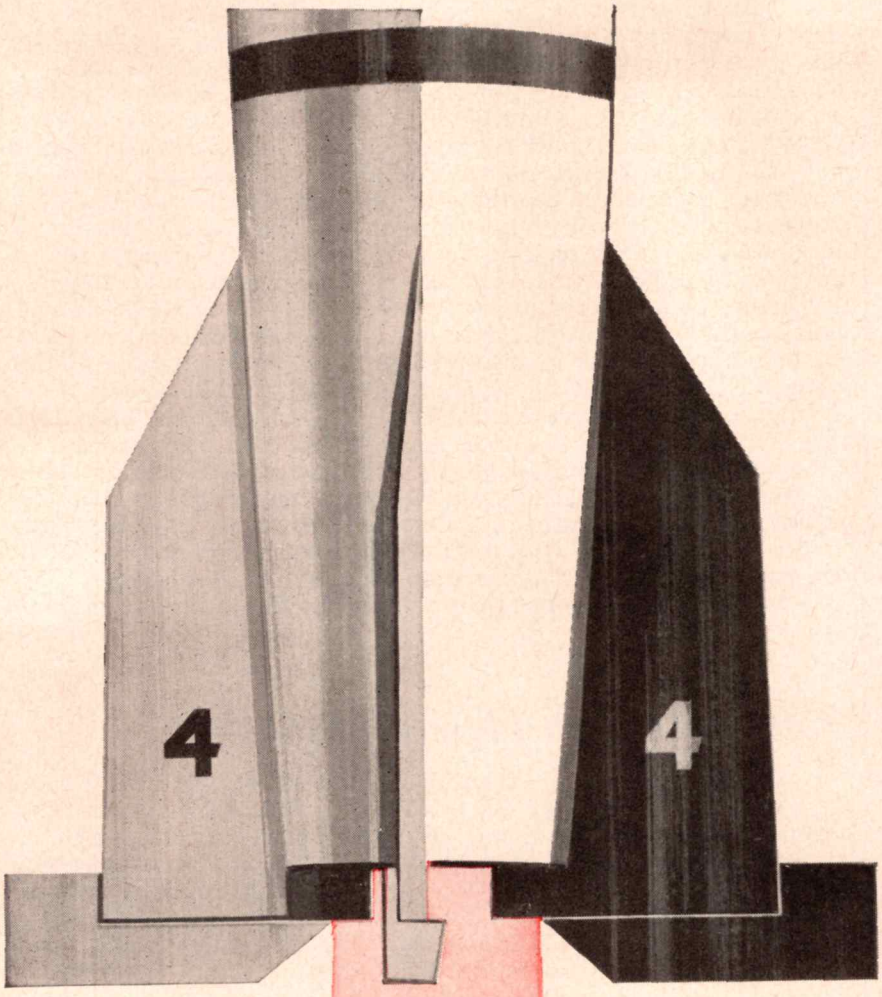
are giving a very fine technical training, and one must therefore conclude that the people who are also in the design bureaus, their civilian scientists and technicians, must be getting an equal or better training to do the job that they have to do." It may be assumed that in the advanced fields of guided missiles and similar projects, the Russians have highly trained and more numerous manpower to concentrate on advancements. This manpower reservoir must be replenished and increased in the U. S. if we expect to keep up with the competition, much less outdistance them. And Russian production methods, on the surface slipshod, have nothing to do with the case. Gen. Irvine, for one, was not fooled by them. He toured a filthy machine shop with 1940 machine tools. "But on those machine tools the Soviets built over 10,000 engines of high quality." If the quality falls off, the Russians have a quick answer for the personnel responsible—off they go to Siberia. "I can only come to one conclusion," General Irvine says by way of warning: "In such areas as ballistic missiles, nuclear bombers, chemical bombers, long-range interceptors, we must do everything we can to marshal the people and the resources into those programs to the fullest extent."

Piasecki Builds Flying Cranes

Another new development in the vertical lift field is promised by an Army contract with Piasecki Aircraft Corporation for advanced designs of giant "flying crane" helicopters. Army goal is a flying crane that will carry greater loads farther than any helicopter now in operation. Piasecki will analyze and design optimum configurations, including helicopters that will lift 16 tons 100 miles in subzero and desert temperatures.

Names in the News

VICE ADMIRAL WILLIAM V. DAVIS, JR., USN, appointed by the President to succeed VICE ADMIRAL THOMAS S. COMBS, USN, as a member of the NACA . . . Union Switch & Signal Division of Westinghouse Air Brake Co. elected FRANKLIN E. LOWANCE Vice President of Research and Engineering . . . DR. SAMUEL B. BATDORF has joined Lockheed Missile Systems division's research branch as Assistant Director and Head of the Electronics Division . . . DR. DANIEL T. SIGLEY, formerly with American Machine & Foundry Co., now Chief Engineer for the Guided Missile Division of the Firestone Tire & Rubber Co. of California . . . WILLIAM M. DUKE, former Vice President of Cornell Aeronautical Research Laboratory, will direct Titan ICBM program at The Ramo-Wooldridge Corp. . . . American Machine & Foundry Co. appointed RUSSELL A. KIMES Director of its General Engineering Laboratories . . . New President of Narmco Metlbond Co. is LAWRENCE R. STEINHARDT . . . W. D. FULLER named Chief Engineer of Varo Mfg. Co. . . . BRIG. GEN. WILLIAM L. BAYER, USA, (Ret.), joined Tele-Dynamics, Inc. as Executive Vice President and General Manager . . . The Powerad Co., Inc. now headed by RICHARD U. SURBECK, former Vice President . . . Republic Aviation Corp. appointed ROBERT W. BOESEL Chief Project Engineer for the Guided Missiles Division . . . BRIG. GEN. HARRISON SHALER, USA, (Ret.), serving as Corporate Army Advisor to Aerojet-General Corp. . . . Newly-created Technical Military Planning Operation, organized in Defense Electronics Division of General Electric, to be managed by DR. RICHARD C. RAYMOND . . .



HIGHER ENERGY than H_2O_2, red and white fuming HNO_3 and mixed acids

...and a combination of other properties uniquely suited to many applications

NT-I-I-3

NITROGEN TETROXIDE (N_2O_4)

Oxidant for liquid rocket propellants

Molecular Weight	92.02
Boiling Point	21°C
Freezing Point	−11.3°C
Latent Heat of Vaporization	99 cal/gm @ 21°C
Critical Temperature	158°C
Critical Pressure	99 atm
Specific Heat of Liquid	0.36 cal/gm −10 to 200°C
Density of Liquid	1.45 at 20°C
Density of Gas	3.3 gm/liter 21°C, 1 atm
Vapor Pressure	2 atm at 35°C
Availability	Good — in 125 lb. steel cylinders and 2000 lb. containers
Handling	Easy — can be shipped, piped, or stored in ordinary carbon steel. High chemical stability.

Allied Chemical — NITROGEN DIVISION

40 Rector Street, New York 6, N. Y.

Ethanolamines • Ethylene Oxide • Ethylene Glycols • Urea • Formaldehyde • U. F. Concentrate—85 • Anhydrous Ammonia • Ammonia Liquor • Ammonium Sulfate • Sodium Nitrate • Methanol • Nitrogen Tetroxide • Nitrogen Solutions • Fertilizers & Feed Supplements

For further information circle Reader Reply No. 3

Rascal the strike from "nowhere"

Bell Aircraft's GAM-63 Rascal is an air-launched guided missile designed to carry out bombardment of strategic military targets—*without the need of bombing runs on the target.*

Rascal is carried by USAF long range bombers and released miles away from its destination, with the bomber well outside the perimeter of local defenses. Then, while Rascal is speeding one way towards the target, the bomber already is headed for its home base in the opposite direction.

In this manner, Rascal could extend the useful life of the nation's bombardment aircraft and eliminate many hazardous operations for the crews of these bombers, thereby fulfilling two important economic and human goals of a strong Air Force.

The rocket-powered Rascal's ability to hit a target while the bomber aircraft is miles away has been demonstrated in a flight test program conducted in conjunction with the Air Research and Development Command.

Bell Aircraft has the weapon system responsibility for Rascal and with the cooperation of its many subcontractors, has developed the electronic, servo and propulsion systems for this air-to-surface missile as well as the airframe, launching, ground handling and training equipment.

The Air Force-Industry team urgently needs scientists and engineers for projects vital to the nation's defense. Opportunities to make important contributions are offered in military or civilian careers.

BELL Aircraft CORP.
BUFFALO N.Y.

For further information circle Reader Reply No. 10

POWER FOR THE WORLD'S AIRLINES

Eight types of
gas turbine powered
airliners on order
by world airlines are
being offered with

ROLLS-ROYCE
GAS TURBINES

AVON	THE DE HAVILLAND COMET SE 210 CARAVELLE
CONWAY	BOEING 707 DOUGLAS DC-8
DART	VICKERS VISCOUNT FAIRCHILD FRIENDSHIP
TYNE	VICKERS VANGUARD LOCKHEED ELECTRA

Rolls-Royce gas turbines have already flown more than 1,250,000 hours on scheduled airline service

ROLLS-ROYCE AERO ENGINES LEAD THE WORLD

For further information circle Reader Reply No. 34

Every wolf would like to eat a porcupine. Few of them get around to it. What makes the porcupine's meat so good, of course, is the fact that he doesn't have to do any running. Wolves, by and large, are an ill-tempered, frustrated lot, while you almost never see a neurotic porcupine. He figures it's cheaper to carry a quiver full of arrows than to get ulcers from hiding. There are predators of the sky, too, and helping keep them in a state of frustration is REPUBLIC'S job building THUNDER-CRAFT.

25 YEARS

REPUBLIC AVIATION

FARMINGDALE, LONG ISLAND, N. Y.

Designers and Builders of the Incomparable **THUNDER-CRAFT**

For further information circle Reader Reply No. 33

MOST PROFITABLE AIRLINER

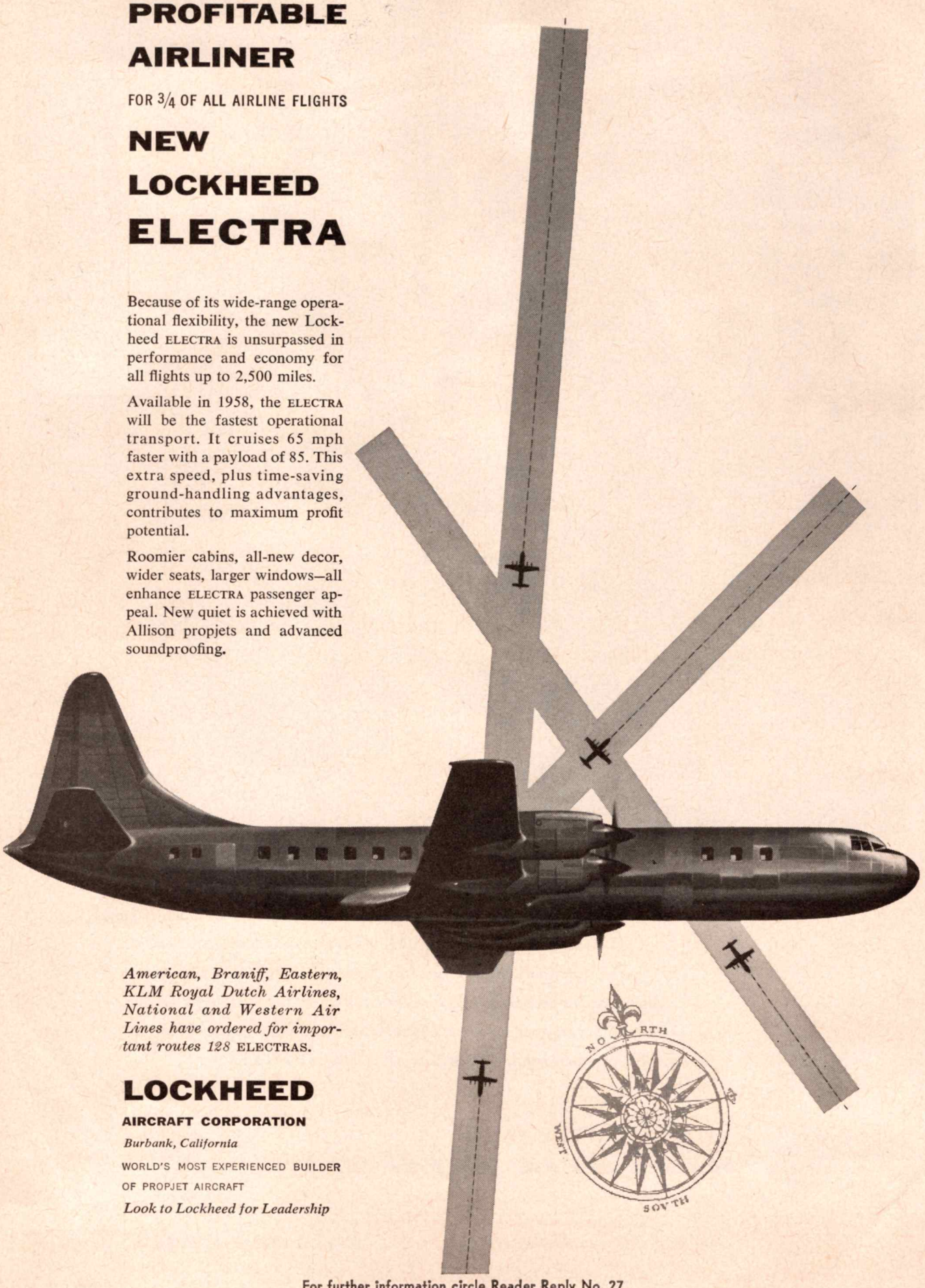
FOR 3/4 OF ALL AIRLINE FLIGHTS

NEW LOCKHEED ELECTRA

Because of its wide-range operational flexibility, the new Lockheed ELECTRA is unsurpassed in performance and economy for all flights up to 2,500 miles.

Available in 1958, the ELECTRA will be the fastest operational transport. It cruises 65 mph faster with a payload of 85. This extra speed, plus time-saving ground-handling advantages, contributes to maximum profit potential.

Roomier cabins, all-new decor, wider seats, larger windows—all enhance ELECTRA passenger appeal. New quiet is achieved with Allison propjets and advanced soundproofing.



American, Braniff, Eastern, KLM Royal Dutch Airlines, National and Western Air Lines have ordered for important routes 128 ELECTRAS.

LOCKHEED

AIRCRAFT CORPORATION

Burbank, California

WORLD'S MOST EXPERIENCED BUILDER OF PROPJET AIRCRAFT

Look to Lockheed for Leadership

For further information circle Reader Reply No. 27

Is your Jet Engine RPM Measurement Accurate???

The NEW B&H Instrument

TAKCAL

• COMPACT
• LIGHT
• RUGGED

• • • Reads Jet Engine Speed to Guaranteed Accuracy of 10 RPM in 10,000 RPM (±0.1%)

Checks Tachometer System

Adapts to any Frequency Problem

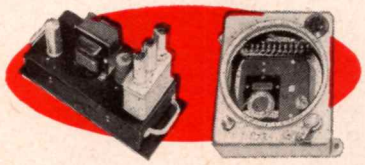
The inter-relation of RPM to efficiency and thrust in jet engines is fundamental. Proper adjustments for maximum thrust, engine life and safety of operation can be made only upon accuracy of instrumentation.

The new B&H TAKCAL incorporates a refinement of the frequency meter principle. It operates in the low (0 to 1000 cps) range, reading the frequency of the tachometer generator on a scale calibrated in percent RPM corresponding to the engine's RPM. In addition, the TAKCAL checks the tach system. The TAKCAL circuit and tachometer are parallel so that readings can be made simultaneously to determine the accuracy (or inaccuracy) of the aircraft's tach system. The TAKCAL operates during the engine run to properly set up engine controls for maximum economy and safety.

The TAKCAL's component parts are identical with those used in the J-Model JETCAL Analyzer. They are here assembled as a separate unit tester and for use with all earlier models of the JETCAL Tester.

The TAKCAL operates accurately in all ambient temperatures from −40°F. to 140°F. Low in cost for an instrument of such extreme accuracy, it is adaptable to application in many other fields.

Explosion-proof TAKCAL for special applications. Measures 200 to 7500 RPM, direct reading, with ±0.1% accuracy.



TAKCAL

West Coast Office: 427 E. Grand Ave. El Segundo, Cal.

For full information write or wire

B & H INSTRUMENT CO., INC.
3479 West Vickery Blvd., Fort Worth 7, Texas

For further information circle Reader Reply No. 8

new books

SATELLITE, Erik Bergaust and William Beller, 1956, Hanover House, New York. 287 pp, $3.95.

A semi-technical book that describes in detail the present state of the artificial satellite art, SATELLITE is said by its publishers to be the best book out on the subject. Since it is the only book out on the subject and since one of its authors is a member of the AERO DIGEST staff, opposition is futile.

Actually, the book is quite readable, from its introduction by Professor Hermann Oberth to its concluding chapter on Men Wanted, which is a discussion of the opportunities open to engineers entering the missile and satellite fields.

After tracing the history of the early orbiter designs, the authors give the technical facts behind Project *Vanguard* and describe the environment the first satellite will be exploring. Two chapters are devoted to the practical implications of satellite research, what these vehicles can tell man about himself and how man is expected to react to this new information. Later chapters deal with the International Geophysical Year—the time for the first use of artificial satellites — with larger satellites such as K. A. Ehricke's satelloid, and with the questions of survival of man in space.

Circle Reader Reply No. 90

ASYMPTOTIC EXPANSIONS, A. Erdélyi, 1956, Dover Publications, Inc., New York. 108 pp, $1.35 (paper bound).

Here is an unabridged republication of a monograph prepared for the Office of Naval Research. Unavailable for some time, it presents new and recent methods based on research done for the U. S. Navy. It is an introduction to various methods for the asymptotical evaluation of integrals containing a large parameter and to the study of solutions of ordinary differential equations by means of asymptotical expansions.

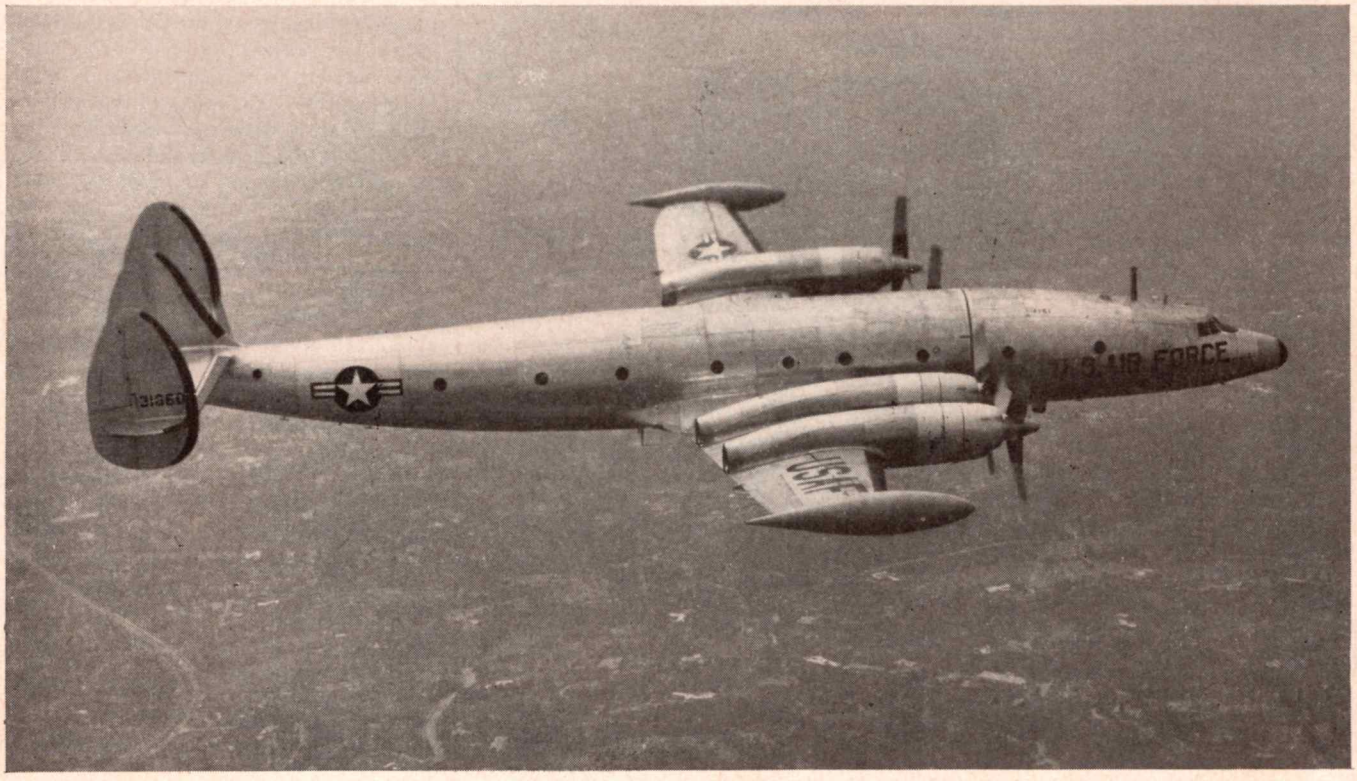
Circle Reader Reply No. 91

ELECTRICAL INTERFERENCE, A. P. Hale, 1956, Philosophical Library Inc., New York. 122 pp, $4.75.

Whether called upon to design electrical apparatus conforming to legal requirements relating to interference suppression, install new receivers or aerials, or trace and eliminate existing interference, electrical engineers and radio and television technicians will find this volume quite valuable.

Circle Reader Reply No. 92

Turboprop transports with set records on



THE LOCKHEED YC-121F, powered by four Pratt & Whitney T-34 turboprop engines, is the world's fastest propeller-driven transport. The aircraft cruises at 420 mph.

A PRATT & WHITNEY AIRCRAFT T-34 turboprop engine is loaded aboard a YC-97J Boeing Transport.

MATS COMMANDER Lt. General Joseph Smith cites the engine's record: "My Continental Division reports that these power plants require considerably less maintenance than that required for any of our larger transport engines in common use. This remarkable record forecasts the fine service we can expect from the Douglas C-133A transports which will soon be in MATS operation." Pratt & Whitney Aircraft is most grateful for the magnificent accomplishments of MATS which are contributing very substantially to the success of the T-34.

PRATT & WHITNEY AIRCRAFT
DEPENDABLE ENGINES

For further information circle Reader Reply No. 42

T-34 engines MATS World Routes

6000-horsepower T-34s show their stamina in Boeing and Lockheed transports

The Military Air Transport Service is already using Pratt & Whitney Aircraft T-34 engines in Boeing YC-97Js and Lockheed YC-121Fs on its world routes. This engine also powers the Douglas C-133A, the highest payload production transport ever to go into service.

The outstanding service performance of the T-34 engine is another example of Pratt & Whitney Aircraft's continuing leadership in design, development and production of dependable engines.

New records include—

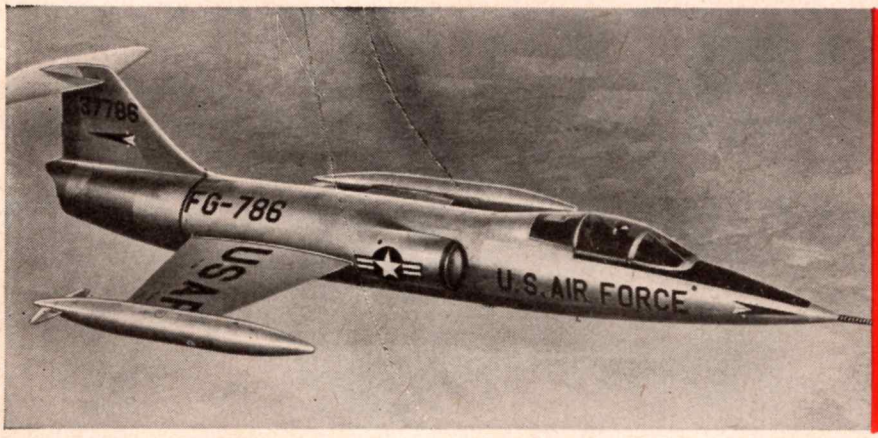
- A Lockheed YC-121F flight from over Gander, Newfoundland, to abeam of Shannon, Ireland, in 4 hours and 13 minutes.
- Boeing YC-97J round trips from Texas to Germany and Japan, the first turboprop transport flights across both Atlantic and Pacific.
- A new in-service MATS record, set when two YC-97Js flew a total of 46 hours and 35 minutes during a single 24-hour period.

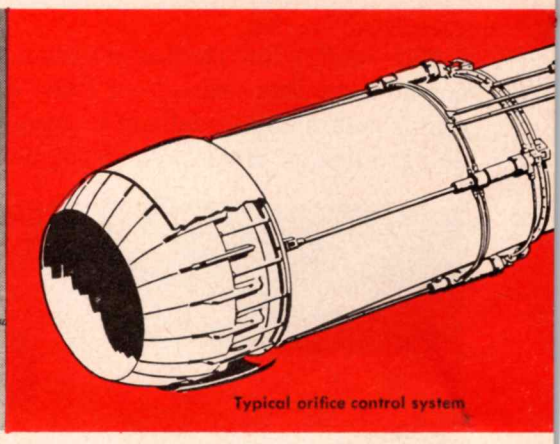
EACH BOEING YC-97J has accumulated over 1000 flight hours and their engines are already operating over 500 hours between overhauls. These aircraft have maintained 6.1 hours daily utilization during a single month, demonstrating the reliability of the airframe, propeller, engine combination.

PRATT & WHITNEY AIRCRAFT

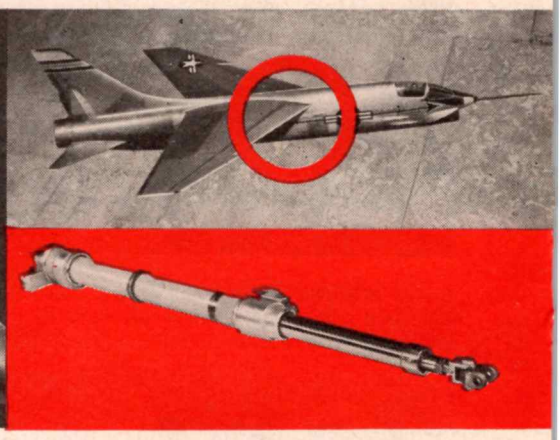
Division of United Aircraft Corporation • Main Office and Plant: East Hartford, Connecticut
Branch Plants: North Haven—Southington—Meriden

Vital accessories for the fastest fighters



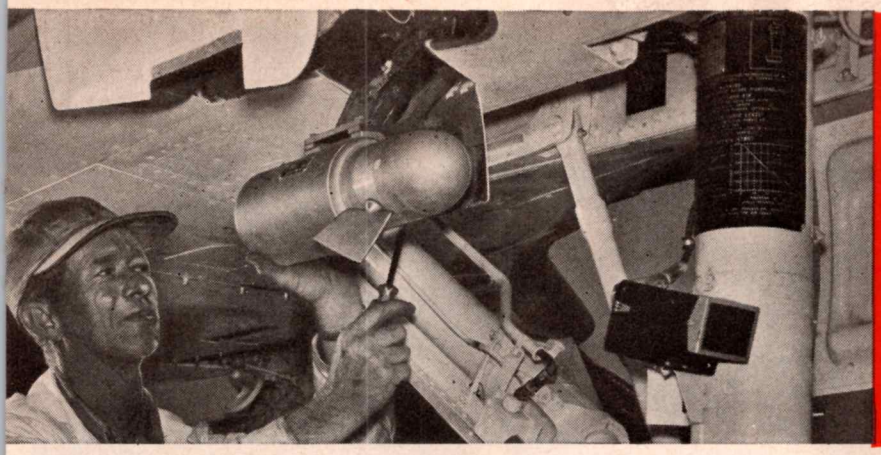

Typical orifice control system

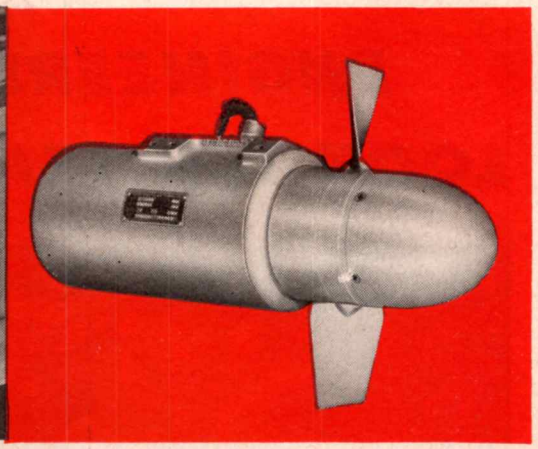
AFTERBURNER ACTUATORS – *the Lockheed F-104A Starfighter,* world's fastest fighter plane, has four Aeroproducts actuators on the afterburner for orifice control of its J79 engine. Designed for extremely high temperature operation, these hydraulic actuators are synchronized to co-ordinate in perfect unison, providing instant, positive control of the afterburner nozzles. This patented feature of mechanical synchronization provides precision positioning by incorporating flexible shafting within the hydraulic tubing to co-ordinate the linear travel of the actuator pistons. Another safety factor is a stroke limiter which prevents the tail cone from closing completely in the event of hydraulic failure.



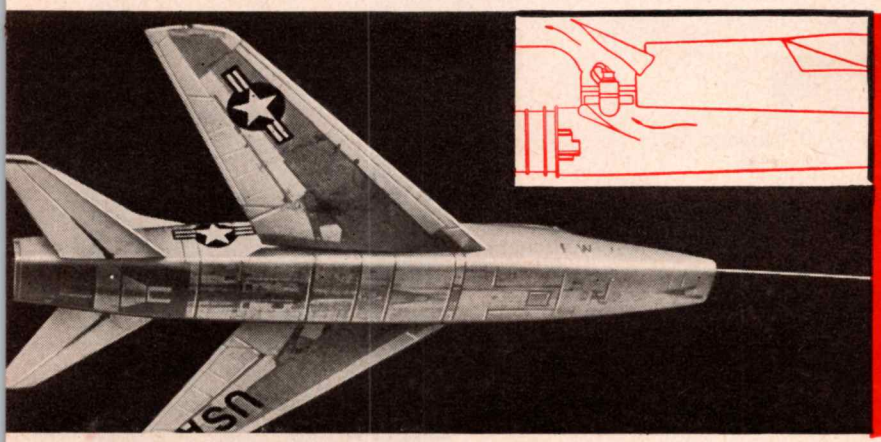
WING INCIDENCE ACTUATORS – *the Chance Vought F8U-1 Crusader,* world's fastest Navy fighter plane, showing its unique two-position incidence wing in "up" position for take-off. Inset shows normal flight position. First operational plane to incorporate this principle, the F8U-1 has an Aeroproducts self-locking hydraulic actuator which controls the angle of attack of the wing. Changing the wing angle permits the Crusader to land level with the runway of the carrier deck, giving the pilot better visibility and permitting use of shorter, lighter landing gear.

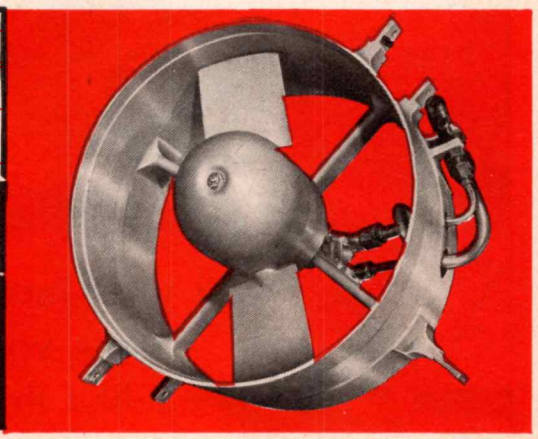
For further information circle Reader Reply No. 5





RAM AIR-DRIVEN GENERATORS – *in the Douglas A4D Skyhawk* – Aeroproducts emergency air-driven generator is first production application of ram air-driven equipment. Suspended beneath the fuselage, this lightweight unit (22 lbs.) gets up to speed in less than 1/10th second and develops 1.7 KVA @12,000 R.P.M. to operate radio, lights, instruments, trim tab and elevators. It has successfully performed in emergencies and has been dropped out many times on flight tests. Using a simple blade pitch changing mechanism, the unit governs its output frequency within plus 10% and minus 5% over a very wide range of airspeed, altitude and load conditions. This unit also has application in tow targets to generate power for scoring mechanisms.





AIR-DRIVEN HYDRAULIC PUMP – *the North American F-100D Super Sabre* is equipped with an Aeroproducts air-driven hydraulic pump which produces sufficient hydraulic pressure for flight controls in case of either engine or hydraulic failure. This lightweight ram air pump is mounted back of the cockpit, where air from engine air inlet ducts can be directed by the pilot to drive the turbine-pump in emergencies.

Precision is the keynote of our work at Aeroproducts. Turbo-propellers and other essential aircraft components are produced by engineers experienced in designing equipment to meet specific requirements of our customers.

Aeroproducts linear actuators – proved in a wide variety of uses–offer many exclusive advantages: low weight with high strength, precision positioning, self-locking, high-temperature operation, compactness and reliability. New rotary actuators provide high torque-carrying capacity with near-zero backlash for control surfaces of missiles.

Any combination of systems–hydraulic, pneumatic, electrical or manual–can serve as the primary power source. And these actuators can be synchronized both hydraulically and mechanically to provide co-ordinated control of related movements.

Let Aeroproducts–with its broad engineering background –work with you on designs for your actuators as well as ram air-driven generators and hydraulic pumps for any application. Write us on your company letterhead for our newest brochure, "Actuators for Aircraft."

OTHER AEROPRODUCTS ACTUATORS include:

Airplanes and Missiles

- Landing Gears
- Flaps
- Spoilers
- Flight Brakes
- Primary Flight Control Surfaces

Aircraft Engines

- Ram Jet and Turbo-Jet Engine Inlet and Exhaust Area Control
- Variable Engine Duct
- Jet Engine Thrust Spoilers and Reversers
- Engine By-Pass Door Control

Building for today... Designing for tomorrow

Aeroproducts

ALLISON DIVISION OF GENERAL MOTORS • DAYTON, OHIO

ENGINEERS...
LOOK TEN YEARS AHEAD!

A Douglas engineer lives here

Will your income and location allow you to live in a home like this...spend your leisure time like this?

They can...if you start your career now at Douglas!

Take that ten year ahead look. There's a fine career opportunity in the engineering field you like best waiting for you at Douglas.

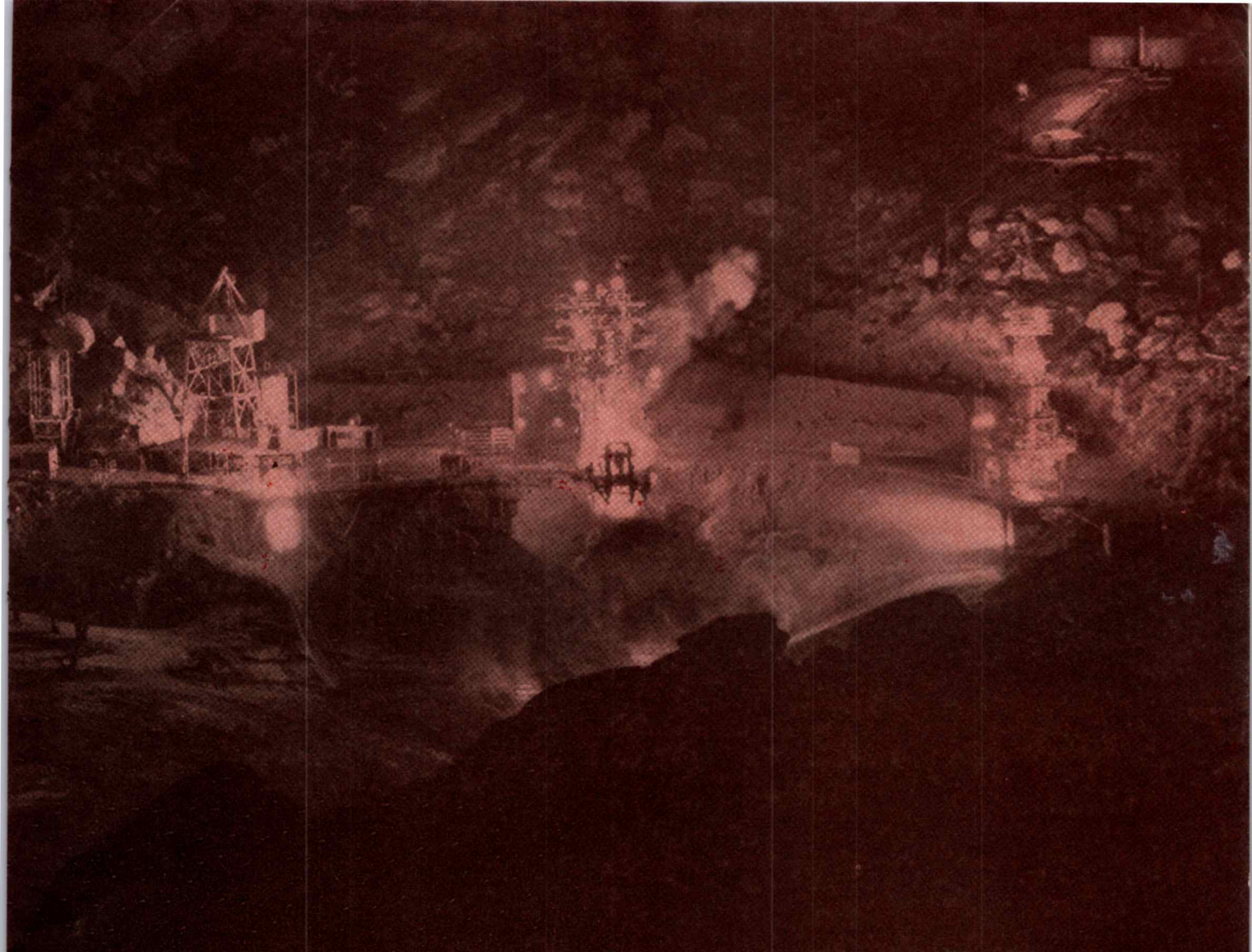
And what about the Douglas Aircraft Company? It's the biggest, most successful, most stable unit in one of the fastest growing industries in the world. It has giant military contracts involving some of the most exciting projects ever conceived...yet its commercial business is greater than that of any other aviation company.

The Douglas Company's size and variety mean that you'll be in the work you like best—side by side with the men who have engineered the finest aircraft and missiles on the American scene today. And you'll have every prospect that ten years from now you'll be where you want to be career-wise, money-wise and location-wise.

For further information about opportunities with Douglas at Santa Monica, El Segundo and Long Beach, California and Tulsa, Oklahoma, write today to:

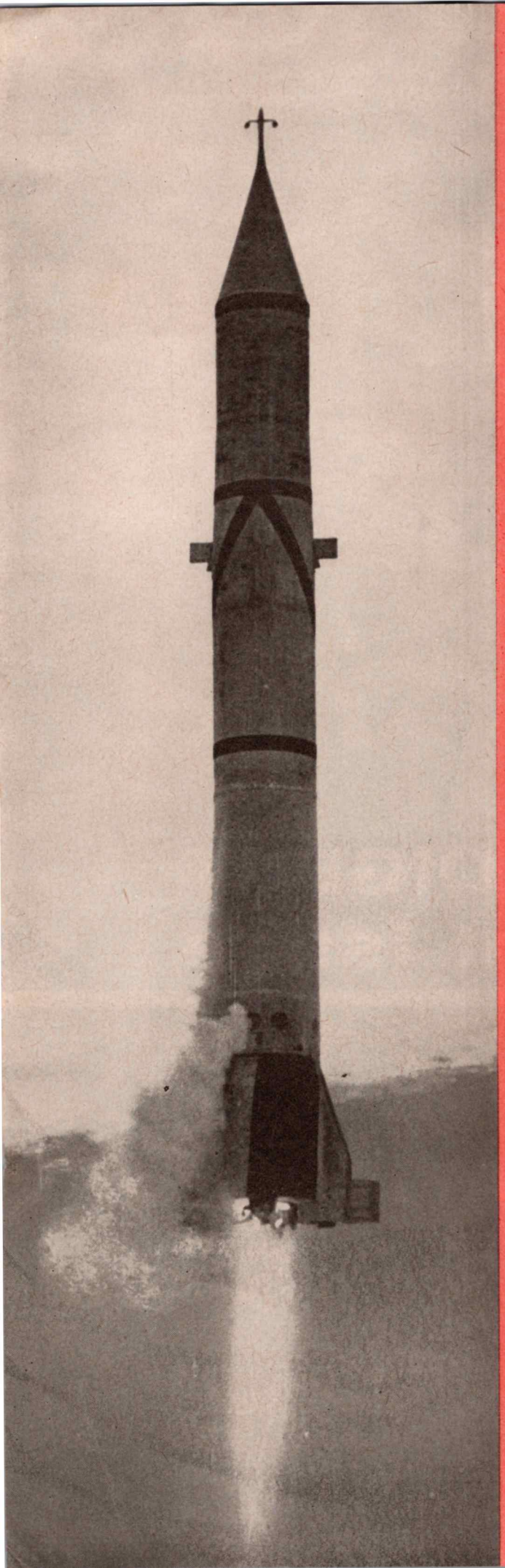
DOUGLAS AIRCRAFT COMPANY, INC.
C. C. LaVene, 3000 Ocean Park Blvd.
Santa Monica, California

DOUGLAS **First in Aviation**



23rd AERO DIGEST Procurement Issue

Featuring ARMY AVIATION in the Atomic Age



ARMY RESEARCH AND DEVELOPMENT In Missiles, Aviation, And Avionics

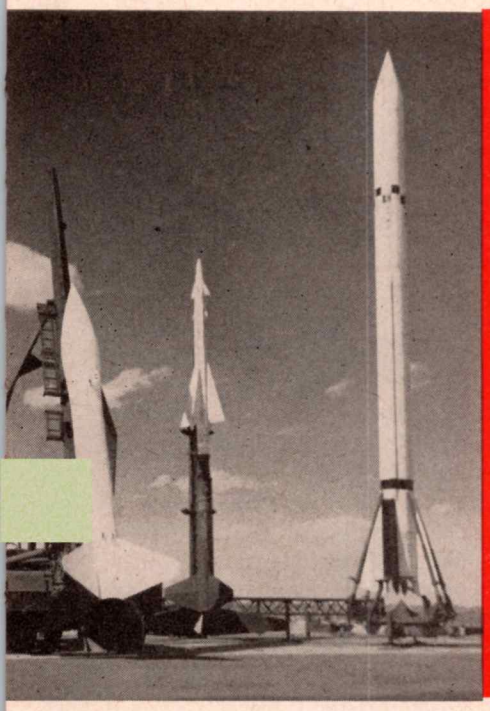
WILLIAM BELLER, AERO DIGEST Managing Editor

Qualified companies and institutions having ideas or facilities available for engineering and scientific work can earn part of the $380-million the Army is spending yearly for research and development. This article describes the most pressing current needs of the Army, lists the responsible Army agencies, and tells what data they want from prospective contractors.

ACCELERATING ADVANCES of science and technology provide our Army with radically new instruments of war. The new weapons and means developed are challenging earlier concepts of time and space. They foretell of future combat characterized by fluidity and widely dispersed units. They require the ground commander to posses a vital mobility for the rapid concentration of his dispersed forces to strike at the decisive place at the decisive time. They demand a vast extension of the battlefield in width and depth. In short, they place a premium on firepower, mobility and communications in future ground conflict.

To exploit the vast opportunities available to enhance its fighting effectiveness, the United States Army expends about $380-million a year on research and development. Research and development designed to provide it with the new missiles, guns, combat vehicles, aircraft, communications and other material, as well as human resources essential to its present and future requirements. Its requirements are diverse and dynamic and cover the entire range of combat activities. They evolve from constant and imaginative investigations by all components of the Army to insure that doctrines and organizations are compatible with the rapidly expanding potentials of modern science and technology. They are stimulated by concepts or accomplishments in basic or applied research continually being tendered by the American scientists or industrialists.

Today, research and development are an integral and vital part of the total Army effort. At the highest level of the Army staff there is a Chief of Research and Development who serves as a Deputy to the Chief of Staff and is directly responsible to him



Three guided missiles set on launchers at the White Sands Proving Ground. (L to R) Honest John, Nike and Corporal.

for the overall supervision of the entire Army research and development program. This is a senior and highly imaginative officer of proven combat experience, who distinguished himself with our Airborne forces in WW II—Lt. General James M. Gavin. Through a staff of competent and qualified personnel, military and civilian, General Gavin plans coordinates and directs all Army research and development.

● ● Research and Development

The actual research and development work is accomplished for the Army through its seven Technical Services: Chemical, Engineers, Ordnance, Quartermaster, Signal, Transportation and Medical. These services have assigned spheres of interest, compatible with their roles in support of the combat forces. They are responsible for accomplishing those research and development projects falling within their assigned spheres of interest. Through their agencies they solicit and receive proposals from individuals or organizations who wish to participate in the research and development projects appropriate to them. The agencies' activities cover all phases of research and development, from the initial steps of basic or applied research through to the production of a prototype model suitable for user test by the component of the Army concerned. They negotiate and award contracts for such work whether it is performed in a military or civilian agency.

In this issue, AERO DIGEST seeks to provide information and guidance for those prospective civilian contractors, individual or organization, interested primarily in participating in those Army research and development programs concerned with missiles, aircraft and avionics. Those interested in other aspects of the extensive Army research and development programs may communicate with the following addressees in the Office of the Chief of Research and Development, who will promptly advise them as to the proper source to satisfy their interests:

Office Chief of Research and Development
Department of the Army
Washington 25, D. C.
Attn: Technical Liaison Branch

● ● Missiles

About 30 percent, or $108-million, of Army expenditures for research and development is devoted to missiles, either the surface-to-surface type or the surface-to-air type.

In the field of surface-to-surface missiles Army developments emphasize the ballistic rather than the forts are aimed towards weapons required by the Army more vulnerable cruise-type air-supported missiles. Efcommander in the field. They include short-range assault missiles of great accuracy, anti-tank missiles and missiles to provide the long range, all-weather, day or night fire power essential for the highly mobile, fast moving, deeply penetrating, widely separated combat actions of the future. Free rockets complement missiles to provide a new family of weapons for a fast striking, hard hitting Army.

As a result of its progress, the U.S. Army has today the only operational ballistic guided missile in the field of any free nation—the *Corporal.* Also operational, and with troops abroad, is the *Honest John* rocket. The Army is developing larger long range missiles such as the *Redstone* and *Jupiter* for theater and Army support, and smaller, more economical missiles for division and battle group support, and meeting outstanding success in those programs. It is improving the range, mobility and lethality of its rockets and is introducing an effective anti-tank missile known as the *Dart.*

In the field of surface-to-air, the Army is concerned with its basic responsibilities for air defense which include, not only the field army and vital installations overseas but also, of prime importance, the provision for Army antiaircraft units for defense of the United States. Anticipating the present air-threat ten years ago, the Army developed the *Nike* system, which is today the only operational land-based air defense missile system protecting our country. Projects are in being to improve the capability of the *Nike* system and to provide additional mobile systems.

The Army also seeks to achieve a system for protection against missiles: the anti-missile missile. Further, the Army is vitally concerned with a light, highly mobile weapons system to improve protection of forward combat units against low flying air attacks.

To provide optimum effectiveness for its installations in being, the Army has developed the electronic *Missile Master* fire-direction system, designed to coordinate fires of large numbers of *Nike* units and other advanced antiaircraft weapons. Emphasis here is laid on automation to achieve maximum speed and minimize human error.

Army contracting for missile research and development is, in the main, accomplished through the Red-

stone Arsenal in Alabama, an agency of the Ordnance. Here is the focal point for the prospective contractor concerned with any aspects of research, basic or applied, or development pertinent to the missile systems, except as noted hereafter. The contractor who has concepts, services or facilities applicable for use in this most urgent and vital program is welcomed and encouraged to forward his proposal (with basic information recommended later in this article) to:

The Commanding General
Redstone Arsenal
Huntsville, Alabama

Missile testing is accomplished at the White Sands Proving Grounds in New Mexico, and those interested in contracts for equipment in support of guided missiles and long-range rocket testing should communicate with:

The Commanding General
White Sands Proving Ground
Las Cruces, New Mexico

Responsibility for developing the warheads and fuzes for missiles and rockets is a responsibility of one of the Ordnance's major arsenals, and contractors in this field should forward proposals to:

The Commanding General
Picatinny Arsenal
Dover, New Jersey

• • Aircraft

The demands for mobility and agility within the battle area has made aircraft an integral part of Army equipment. Aircraft that can move troops and critical combat supplies within the battle area, that can provide the battlefield surveillance essential to the effective employment of the new long-range weapons, are vital.

Basically, the Army aircraft must be capable of operating from unprepared fields, without hard surfaces and without requiring extensive servicing and maintenance facilities. Primary emphasis has been directed towards the helicopter, which proved itself as an Army battlefield item in Korea, and the short or vertical takeoff and landing aircraft that can move key personnel or supplies about the battlefield.

The Army helicopter family includes two cargo and personnel carriers with 1½ ton capacity and two heavier helicopters of 3 and 5 ton capacity. A project is under way to provide a *flying crane* helicopter to give mobility to missiles, armored vehicles and other heavy items. In the field of utility helicopters, a turbine powered model with a gas turbine engine is being developed, a startling innovation to supplement the present conventional powered models in use.

In fixed-wing aircraft, the Army has numerous observation, personnel and cargo carriers suitable for field use. Maximum effort is being placed on exploiting certain technical breakthroughs in design configuration of vertical and short takeoff aircraft. This effort is receiving vigorous support because of its obviously high potential for Army employment.

Even the aerial mobility of the individual soldier is being explored and tests have already been initiated on a flying platform or aerocycle for the heretofore earthbound doughboy.

The Transportation Corps executes the research and development programs for the Army's aircraft requirements. This agency staff will give prompt, full and objective evaluation to any proposals received and expedite channels of contract negotiation. Proposals or queries on Army aircraft research and development program should be sent to:

The Chief of Transporation
Department of the Army
Washington 25, D. C.
Attn: Executive for R & D

The movement of large masses of troops and supplies by air *to*, as opposed to within the battle area, is, of course, a responsibility of the U.S. Air Force. In many instances this involves parachute as well as air landing operations. The Army Quartermaster is responsible for the packaging, containers, parachutes and so forth, which are essential to delivery by parachute—an aspect of aerial mobility of prime importance to the Army. Proposals concerned with this realm of activity should be directed to:

The Quartermaster General
Department of the Army
Washington 25, D. C.
Attn: Office of R & D

• • Avionics

Avionics is defined as the application of electronics to aircraft systems. The Army is concerned with that category of avionics equipment that would be suitable to employment in, or in connection with, the types of aircraft discussed above. These include aircraft flight stabilization equipment, air-ground commuications, air-navigation aids, all-weather instrumentation and so forth. The Signal Corps, which has responsibility for performance of research and development for commnuications, electronics and the like, for the Army in general, also encompasses this field. Proposals therefore should be sent to:

The Army Signal Supply Agency
Laboratory Procurement Office
Fort Monmouth, New Jersey

An activity that can often include both avionics and aircraft skills is the Army program for battle area surveillance using drone aircraft. A special agency is in charge of this program:

Army Liaison Group, Project MICHIGAN
Commanding General, 9550 TSW
Willow Run Laboratories
Ypsilanti, Michigan

• • Proposals

Considerable time may be saved individuals and organizations making definite contract proposals if there is initially a clear understanding of the nature of their desired participation in the Army's research and development programs. To the extent practicable, the prospective contractor should include the following basic information in his initial letter:

1) Organization information to include:

a. Name and type of company.

b. Number of employees. Indicate available research scientists, development engineers or other technical personnel.

c. Facilities. A brief description of laboratory equipment and other facilities pertinent to research and development capabilities.

d. Facility Clearance. If presently held, show from which Department it was issued; viz: Army, Navy, Air Force.

e. Brief background on work previously done in proposed field.

f. Descriptive brochure and current financial statement if available.

2) Clear and full discussion of the proposed work in terms of objectives and scope. Include diagrams or sketches as apropriate.

3) Probable time required for completion.

4) Procedure to be followed in initiation and continuance of work.

5) Estimates of costs, with breakdown by years if more than one year is involved.

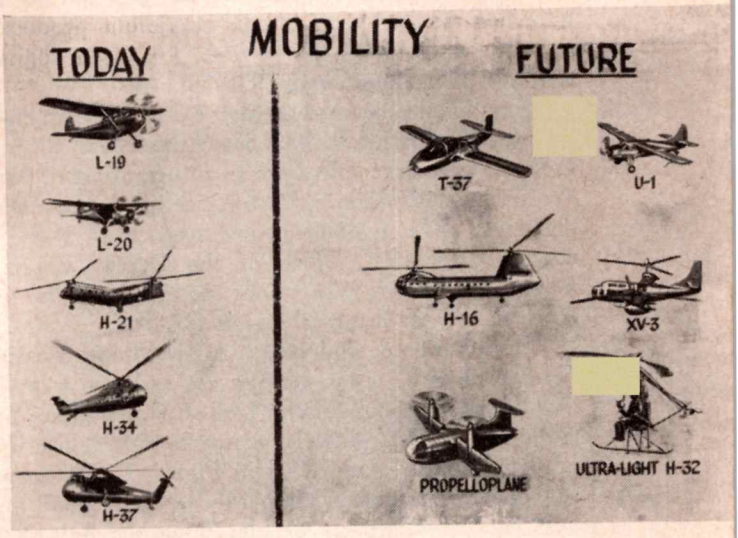
If an individual or organization has no specific offer of services or facilities to make in connection with any specific project, but merely desires to be listed on the particular agency records as a potential candidate for future work, a statement to that effect with useful background data would be most welcome.

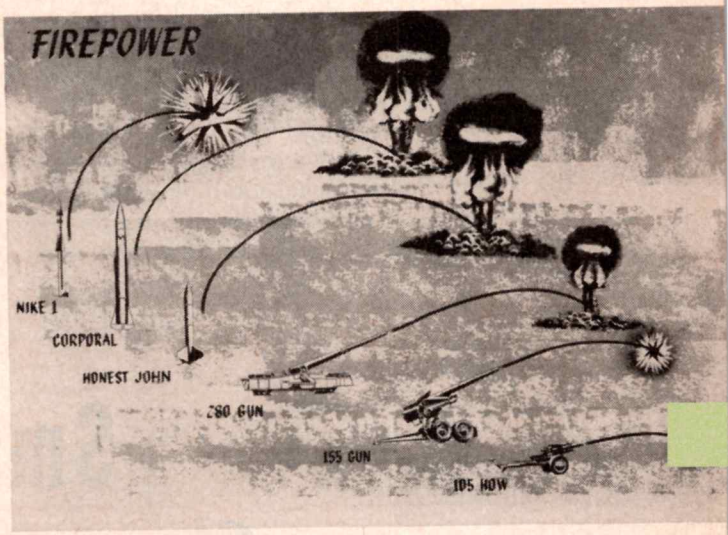
The Army is anxious to cut red tape in the processing of these proposals and considers that the important aspect of initial contacts is to put the applicant in touch with the agency concerned with his activities. This is the key step. Once that is accomplished the many details pertinent to specific proposals and contract negotiations can be expeditiously carried on by the agency which, with the contractors, shares a keen and urgent interest in the job to be done. Once a project is embarked upon, every effort is made by the Army agencies handling these research and development contracts to eliminate such items as unnecessary administration, paper work and reports that tend to slow up constructive progress on a project.

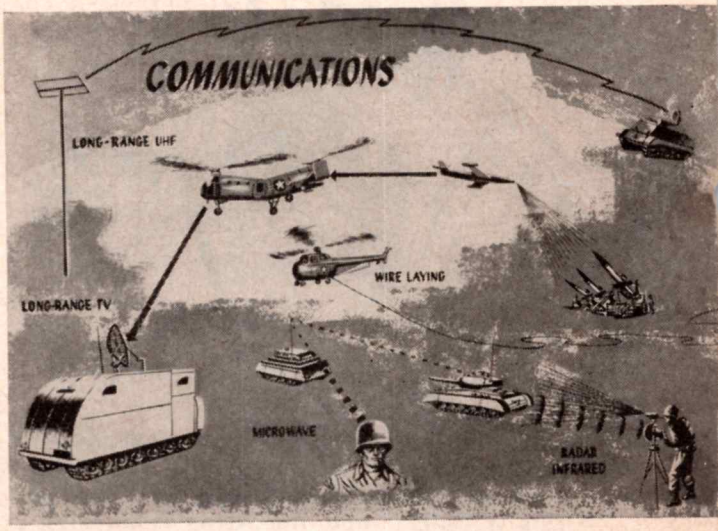
● ● Conclusion

Whatever the developments of the future, the Army must rely on American science and technology to give it the best weapons, machines and allied equipment, that industry can produce. To these will be added the skill and spirit of our modern Army.

As General Gavin has stated, "The U.S. Army seeks to employ the inventive genius of American science and industry, which is one of the remarkable phenomena of our time, to give flexibility to its weapons systems. We seek to develop weapons systems that have all the inherent flexibility of our democracy itself. For democracy is a flexible entity and will be well served only when the weapons systems that are its servants, are equally flexible, capable of meeting the varigated demands of national policy, whatever they may be, capable of applying power with discrimination swiftly and severely when our people choose to do so. An Army that has this capability will serve our people's needs and our diplomacy." ◆ ◆







Small Business in the

BRIG. GEN. A. F. CASSEVANT
Chief, Procurement Division
Office of the Deputy Chief
of Staff for Logistics

THE DEPARTMENT OF THE ARMY has long recognized from experience the desirability of utilizing small business firms during full and partial mobilization, in order to obtain maximum production capacity, and during peace time, to obtain competition and to maintain economic balance.

Army Small Business Policy is clearly enunciated in Army Regulation 715-3. The Army Small Business Program and Procedures are an integral part of Army Procurement Procedure, Part 7, Section XXX. These documents are available upon request to the Procurement Division, Office of the Deputy Chief of Staff for Logistics (Attention: Army Small Business Advisor, Pentagon, Washington 25, D.C.)

Three hundred and sixty Army Small Business Specialists and Representatives are assigned to Army installations throughout the United States where procurements are currently being made, either on a local or national basis, as shown in Figure 1. These personnel are provided by the Army to assist small business concerns desirous of furnishing the Army's requirements either as a prime contractor or subcontractor.

Army aids are available to small business concerns and the Army Small Business personnel; that is, (1) sixty exhibits and sample and display rooms at major purchasing activities consisting of typical items currently being procured, (Figures 2, 3, 4 and 5); (2) brochure of principal purchasing offices throughout the United States, alphabetical by state, Figure 6; and (3) booklet of Army prime contractors engaged in contracts with the Army for $1-million or more.

GENERAL ALBERT F. CASSEVANT joined the staff of the Chief Signal Officer, Washington, D. C., in July 1951 and was assigned to the Procurement and Distribution Division. He became the Assistant Chief of this division in November 1951, serving in this capacity until June 1954. In June 1954, General Cassevant was named Signal Officer of the Army Forces Far East, with headquarters in Tokyo. He left this assignment in September 1955 to return to the United States and again joined the staff of the Chief Signal Officer, Washington, D. C., serving in this capacity as Chief, Procurement and Distribution Division until 3 January 1956 when he assumed his present assignment as Chief, Procurement Division, Office, Deputy Chief of Staff for Logistics.

Small businesses are being encouraged to obtain prime contracts from the Army and subcontracts from the Army's prime contractors. This is policy, and the Army is backing it up with personnel and printed aids.

It is the policy and philosophy of the Army that small business concerns should be afforded an equitable opportunity to compete for the supplies and services being procured by the Army. Such an equitable opportunity prevails when the following criteria are met relative to those supplies and services which are susceptible of accomplishment by small business:

1) The bidders' mailing list for the item or service includes the names of established small business suppliers or names of potential small business suppliers who have made acceptable application for inclusion in the list.
2) Invitation for Bids or Request for Proposals are sent to all firms, large and small, on the list. When they are sent to less than the complete list, a pro rata percentage of small business concerns is included among those solicited.
3) The quantities being procured are appropriate or, when practical, bids or proposals permit partial bidding.
4) Specifications are available, adequate and clear to enable firms to submit a bid or proposal.

5) Drawings are available or accessible for the purpose of preparing a bid or proposal.
6) Delivery schedules are realistic and reasonable so as to permit small business to participate.
7) The time allowed for the preparation and submission of a bid or proposal is adequate to permit small business to present an accurate and intelligent bid or proposal.

Army Small Business and procurement personnel are continually making every endeavor to carry out the policy and philosophy of an equitable opportunity. By virtue of the application of the policy and philosophy, the Army has placed prime contracts with small business concerns during the first 11 months of Fiscal Year 1956 (July 1955 through May 1956) in the amount of $1,370,262,000. This figure represents 41 percent of all dollars obligated by the Army during this period.

During the first six months of Fiscal Year 1956, small business concerns participated in all sizes of procurements being placed by the Department of the Army as evidenced by Table 1. The army is proud of this achievement.

The dollars awarded to small business do not reflect what small business firms further received on a subcontract basis from Army prime contractors. However, a survey made by the Senate Select Committee on Small Business (Senate Report #306, April 28, 1953) revealed that an additional 24.3 percent was subcontracted to small business firms on a first tier subcontract basis.

In the field of Research and Development in which the Army placed prime contracts, during this same period of time, the percentage awarded to small business concerns is reflected in Table 2.

Army Picture

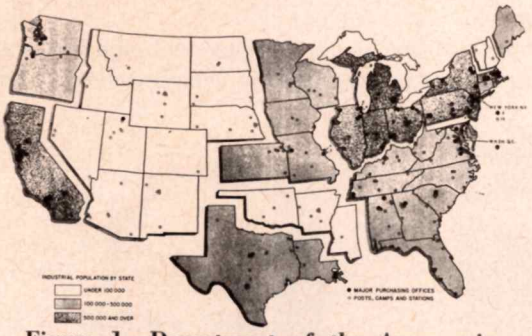


Figure 1—Department of the Army principal purchasing offices (Continental U.S.).

● ● Where Procurement Takes Place

Department of the Army procurement takes place primarily through the major purchasing offices which are located in the most part at every principal city throughout the United States.

Procurement may also take place locally at individual Army installations. Local procurement is generally limited to housekeeping or off-the-shelf items available locally and not distributed through the central supply system, and other products and services of limited dollar needed to fill the special requirements of the individual Army installation.

It is important to remember that Army contracts are secured through the individual purchasing offices mentioned above and not from a central authority in Washington. Trips to Washington for this purpose are therefore fruitless except in specific cases where the purchasing office is actually located there.

● ● How to Obtain Invitations for Bids

Each purchasing office maintains bidders' or sources' lists for the items it buys. To have your firm placed on such lists, apply to appropriate offices for the Bidder's Mailing List Application form (Standard Form 129). To insure an accurate and complete listing of your firm, the information called for by the form should be answered fully.

In advertised procurements, Invitations for Bids are mailed out to firms on the bidders' list in such numbers as in the judgment of the Contracting Officer will insure full competition, generally the entire list where practicable, and are furnished to the extent available to other suppliers upon request.

In negotiated procurements, Requests for Proposals are sent to firms normally selected from the same bidders' list on the same basis as in advertised procurement. Requests for Proposals are likewise furnished, to the extent available, to other suppliers upon request.

Failure to respond to Invitations for Bids or Requests for Proposals mailed to prospective bidders may result in removal from the bidders' list unless the purchasing activity is notified of continued interest.

● ● Methods of Purchase

Purchase may be made either by formal advertising or, under certain specified conditions, by negotiation. Formal advertising is conducted in strict accordance with prescribed procedures. A date and hour for

Figure 2—Typical Bid Board room at Army purchasing offices.

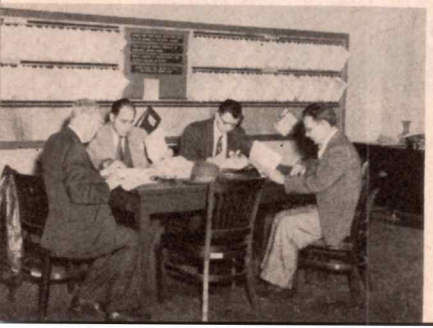


Figure 3—Typical items currently being procured, which Small Business concerns are capable of furnishing.

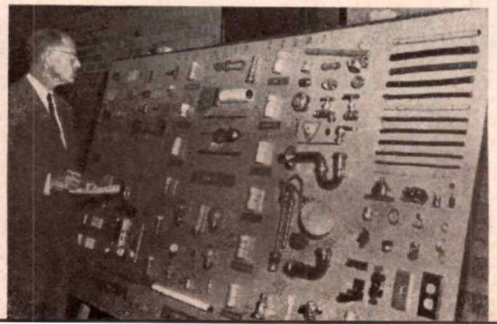


Figure 4—Army guided missile programs afford new and increased contracts.

bid opening is set in advance, and bids are publicly opened and recorded at that time. Award is made to the responsible bidder whose bid, conforming to the Invitation for Bids, is most advantageous to the Government, price and other factors considered. Upon award, the accepted bid becomes a legally binding contract.

To provide a method of procurement for the Armed Services when formal advertising does not meet their needs, the Armed Services Procurement Act sets forth conditions permitting procurement by negotiation. The complicated or experimental nature of the item, the urgency of the requirement, or other considerations covered by these conditions may lead the contracting officer to select this method. The use of the negotiation method does not by any means preclude competition. It is the policy under negotiated procurement to assure full and free competition, consistent with the requirements of the procurement by soliciting quotations from a number of qualified sources and providing Requests for Proposal, to the extent available, to other suppliers upon request. Award is made in the best interest of the Government, considering price, delivery, quality of product, and other factors, on the basis of original quotations or as a result of further negotiations with the firm or firms that submitted the most acceptable proposals.

• • Type of Contracts

The fixed-price contract is generally used for both formally advertised and negotiated procurements. Cost-type contracts are reserved for certain limited situations and may be awarded with or without a fee. Cost-plus-a-percentage-of-cost contracts are prohibited by law. Letters of intent or letter contracts are preliminary contracts which enable a contractor to commence work pending the negotiation and execution of the definitive contract.

Most military supplies are purchased on the basis of uniform standard specifications which describe quality, size, performance and other features of the item to be purchased and state requirements for inspection, testing packaging and packing. When the specifications for an item on which you are bidding are not included in the Invitation for Bids, apply to the purchasing office (except when another place has been specified).

Indexes of military specification and standards may be purchased from the Superintendent of Documents, Government Printing Office, Washington 25, D.C. These indexes list specifications by item and number and indicate for each the responsible technical service.

• • Qualified Products Lists

Certain products require time-consuming, costly or complicated testing to qualify them for purchase. To avoid the need for repetitive testing, such products are covered by Qualified Products Lists. Manufacturers are encouraged to submit samples of their products for approval and inclusion in these lists. The procedure to follow in each case is set forth in the applicable specification. When a product to be purchased is covered by a Qualified Products List, it will be so specified in the Invitation for Bids or Request for Proposal, and only those bids offering products which have been approved need be considered. Manufacturers of products not listed, however, may be given an opportunity to qualify their products prior to award if time permits. Qualified Products lists are always open for inclusion of products from additional manufacturers as they qualify.

• • Security Clearance

A "classified" procurement is one involving restricted, confidential, secret or top secret security information. Firms invited to participate are required to have security clearance or to obtain such clearance prior to entering into contract negotiations. If your firm is being considered for such work the Contracting Officer will make necessary arrangements for the inspection of your plant and the investigation of your personnel.

Before material can be accepted and paid for by the Army, it must be inspected by a representative of the

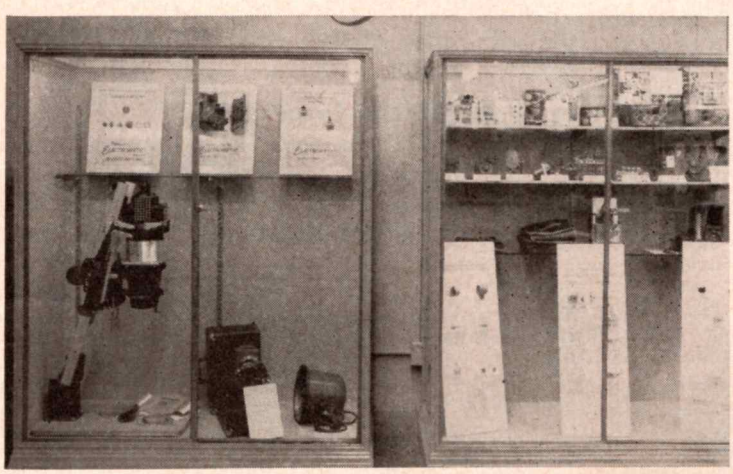
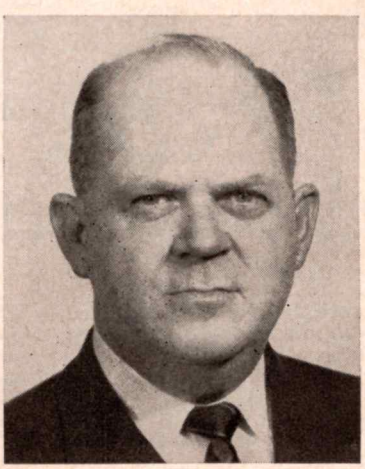


Figure 5—Display of electronic items currently being procured by the Signal Corp. at Philadelphia.



Jack Watt Askins, Small Business Advisor, Pentagon, Wash., D. C.

Government to determine whether it conforms in all respects to the requirements of the contracts. The place of inspection is generally specified in the contract and may be at (1) the place of manufacture, (2) the point of delivery or (3) destination. Inspection of components, subassemblies or end items does not relieve the contractor of the responsibility of meeting all contract requirements (including material specifications, packaging and packing).

The increasing use of quality control techniques by industry is recognized by the Military Departments. Military inspectors may consider the use of such techniques by a contractor in determining whether Government standards are being met.

• • Industrial Mobilization

The Production Allocation Program, sponsored by the Office of the Secretary of Defense, provides a method for the rapid expansion of military production in case of all-out mobilization. Under this program the Military Departments compute their full mobilization requirements for certain selected items and arrange with industry for the allocation of plant capacity to meet those requirements. Arrangements are made with individual firms through the Industrial Mobilization Planning Offices of the Army technical services. It should be understood that contracts are not being presently awarded under this program and that the production schedules developed are to become effective only as future conditions may require.

• • Subcontracting

Many small firms seeking defense work find it advantageous to investigate subcontracting possibilities. There are certain major items of defense procurement, such as aircraft, ships and combat vehicles, which generally are unsuited to the production facilities of small firms. This does not exclude small business from participating in such procurement programs, however, since large portions of these contracts are placed with small firms on a subcontract basis. Subcontractors are selected by the prime contractors and deal directly with them, rather than with the Government. However, the Army urges their prime contractors to subcontract to small business concerns, and the following contract clause has been made mandatory for use in most supply and construction contracts:

"It is the policy of the Government, as declared by Congress, to bring about the greatest utilization of small business concerns which is consistent with efficient production.

DEPARTMENT OF THE ARMY OBLIGATED PROCUREMENT • BY DOLLAR CATEGORIES
1st Six Months FY 56
(In Thousands)

CATEGORY	ADVERTISED				NEGOTIATED			
	ACTIONS		DOLLARS		ACTIONS		DOLLARS	
	SMALL	LARGE	SMALL	LARGE	SMALL	LARGE	SMALL	LARGE
LESS THAN $ 1,000	30136	4372	4666	763	541106	126913	58440	22638
1,000 — 4,999	7710	758	17252	3895	26352	14198	54201	29778
5,000 — 9,999	1721	428	11264	2435	7302	3893	53259	27758
10,000 — 24,999	978	338	18530	6712	4607	3477	73587	56881
25,000 — 49,999	407	156	16294	6852	702	572	27833	23165
50,000 — 99,999	269	155	21347	12131	305	351	22581	27647
100,000 — 199,999	205	70	31392	11716	125	196	20512	33538
200,000 — 299,999	95	15	24317	4530	52	90	14005	25181
300,000 — 499,999	77	30	30579	13023	33	59	13333	27630
500,000 — 999,999	79	30	55705	25471	26	39	18295	35103
1,000,000 — 1,999,999	30	23	39742	30212	3	22	5225	45329
2,000,000 — 4,999,999	4	14	12365	41217	2	15	12930	51108
5,000,000 — OVER	1	4	7607	26124	-	16	-	391849
TOTAL	41712	7393	291060	185081	580615	149841	374201	797605

* DOES NOT INCLUDE INTERDEPARTMENTAL OR INTERSERVICE PROCUREMENT

Table 1. Small and large business participation in the Army procurement program.

DEPARTMENT OF THE ARMY
RESEARCH & DEVELOPMENT PRIME CONTRACTS WITH ALL BUSINESS FIRMS
FIRST 6 MONTHS FY '56
(1 JULY THRU 31 DEC 1955)

	ACTIONS	PERCENTAGE	OBLIGATED DOLLARS	PERCENTAGE
TOTAL	538	100%	$85,607,000	100%
SMALL BUSINESS	228	42.4%	$12,029,000	14.1%
LARGE BUSINESS	310	57.6%	$73,578,000	85.9%

Table 2. Small and large business participation in the Army research and development program.

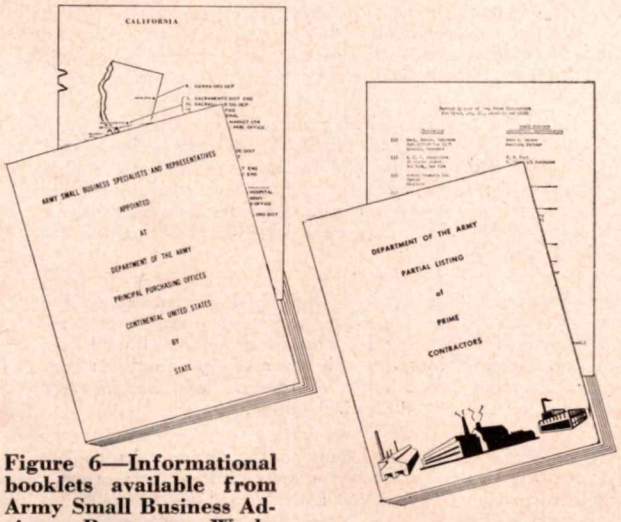


Figure 6—Informational booklets available from Army Small Business Advisor, Pentagon, Washington 25, D.C.

"The contractor agrees to accomplish the maximum amount of subcontracting to small business concerns that the contractor finds to be consistent with the efficient performance of this contract."

For subcontracts, the prospective subcontractor should apply directly to the prime contractors, furnishing information on his plant facilities, production experience, present products, personnel and financial status.

At the present time the Army is engaged in an extensive program with its prime contractors to stimulate the use of small business firms in the subcontracting field. Two hundred and twenty Army prime contractors have appointed an official of their company as their Small Business Liaison. This type of cooperation is evidence that the Army and its price contractors are making every effort to assist qualified small business firms. Names, addresses and the

Table 3. Technical Services Awardin

Service	Contracting Officer	Responsibility
Chemical Corps	Commanding Officer Chemical Corps Research Procurement Office Army Chemical Center, Md.	Contracts for RW and CW research.
	Special Assistant to the Chief Chemical Officer for Biological Warfare Camp Detrick Frederick, Md.	Contracts for BW research.
	Commanding Officer Dugway Proving Ground Dugway, Utah	Contracts for chemical and biological research.
Corps of Engineers	Director, Engineer Research and Development Laboratories Fort Belvoir, Va.	Contracts for all types of research and development for Corps of Engineers except those listed under the following agencies.
	Director, Waterways Experiment Station P. O. Box 631 Halls Ferry Rd. Vicksburg, Miss.	Contracts for research and development of soils mechanics, airfield landing mats and runways, membranes or admixtures for dust-proofing and water-proofing under landing mats, soils stabilization or destabilization, paving materials and Army vehicle mobility.
	Director, Snow, Ice and Permafrost Research Establishment 1215 Washington Ave. Wilmette, Ill.	Contracts for snow, ice, permafrost and frozen ground research.
Ordnance Corps	Commanding General Ordnance Tank-Automotive Command 1501 Beard St. Detroit, Mich.	Contracts at Detroit Arsenal for combat and transport vehicles and gun mounts peculiar to those vehicles, except guns, howitzers and hydropneumatic recoilless mechanisms therefor.
	Commanding General Frankford Arsenal Bridesburg Station Philadelphia 37, Pa.	Contracts for ammunition up to and including 30 mm, except metallic belt links, Cal. .30, .50, .60 and 20 mm; projectiles and cartridge cases for complete rounds of artillery, recoilless ammunition; artillery MT fuzes; cartridge actuated devices; recoilless rifles for light and medium field artillery and antitank towed weapons; fire control equipment; drill ammunition for anti-aircraft guns and recoilless rifles.
	Commanding General Picatinny Arsenal Dover, N. J.	Contracts for complete rounds of artillery projectiles and metal cartridge cases therefor, including drill ammunition; mortar ammunition; recoilless rifle ammunition except cartridge cases, metal parts and fuzes; mines; grenades; fuzes, except MT & VT; bombs; pyrotechnics; demolition equipment; explosives; nonatomic warheads for guided missiles and rockets; impact fuzes for guided missiles; Jatos using extruded and cast double base propellants.
	Commanding General Redstone Arsenal Huntsville, Ala.	Contracts for Jatos less propellants; rockets excluding warheads; rocket launchers (air-to-air); target drones; propellants for guided missiles; rockets and Jatos (except for extruded and cast double base propellants); guided missile systems less special weapons materiel; ground equipment for guided missile systems fuzes for rockets and guided missiles (except VT); drill ammunition for rocket launchers.
	Commanding General Ordnance Weapons Command Rock Island, Ill.	Ordnance Weapons Command is the field command of the Ordnance Corps charged with the research and development responsibilities as delineated under Watertown Arsenal, Rock Island Arsenal and Springfield Armory. However, any proposals for contracts covering the broad areas of research and development should be addressed to the latter installation.
	Commanding Officer Rock Island Arsenal Rock Island, Ill.	Contracts for carriages for towed guns and howitzers and recoilless mechanisms therefore; limbers for guns and howitzers; ground-to-ground rocket launchers; target materiel; linking and delinking machines; hand carts; arm racks; hydropneumatic recoilless mechanisms for combat and transport vehicles and gun mounts.

Contracts for Research and Development Projects.

Service	Contracting Officer	Responsibility
Ordnance Corps (continued)	Commanding Officer Springfield Armory Springfield 1, Mass.	Contracts for belt links, Cal. .30, .50, .60 and 20 mm, including clips; ground type weapons including 30 mm; automatic antiaircraft guns including 20 mm and Cal. .60 machine guns; common machine gun mounts; feeder mechanisms and gun chargers and links therefor.
	Commanding Officer Watertown Arsenal Watertown 72, Mass.	Contracts for towed carriages and mounts for antiaircraft guns and recoil mechanisms and loaders therefor (except antiaircraft guns and sky sweeper); heavy field artillery weapons except guns; rocket launchers (ground-to-air).
	Commanding Officer Watervliet Arsenal Watervliet, N. Y.	Contracts for antiaircraft guns for antiaircraft artillery weapons; guns for light and medium field artillery and antitank towed weapons; guns for heavy field artillery towed weapons; mortars and carriages and carts therefor; guns and howitzers for combat and transport vehicles.
	Commanding Officer Rossford Ordnance Depot Toledo 1, Ohio	Contracts for tools, tool sets and tool equipment.
	Commanding Officer Office of Ordnance Research Box CM, Duke Station Durham, N. C.	Contracts with universities and non-profit institutions.
	Commanding General Aberdeen Proving Ground Aberdeen Proving Ground, Md.	Contracts for equipment in support of ballistic research and engineering test. Function: principal ordnance development center for ballistic research and development and engineering testing on all classes of Ordnance materiel except guided missiles.
	Commanding General White Sands Proving Ground Las Cruces, N. M.	Contracts for equipment in support of guided missiles and long range rocket research and test.
	Commanding Officer Diamond Ordnance Fuze Laboratories Conn. Ave. & Van Ness St. N.W. Washington 25, D. C.	Contracts for VT Fuzes for Ordnance items.
Quartermaster Corps	Commanding General The Quartermaster Corps Research & Development Command Research & Development Center Natick, Mass.	Contracts for all types of research and development for Quartermaster Corps.
Signal Corps	Chief, Laboratory Procurement Office Signal Corps Supply Agency Watson Area Fort Monmouth, N. J.	Contracts for all types of research and development for Signal Corps.
Surgeon General	The Surgeon General Department of the Army Main Navy Building Washington 25, D. C. ATTN: Research and Development Division	Policy and procedure for Army contracts for all types of medical research and development for Army.
	Chairman Armed Services Medical Materiel Standardization Committee 23rd and E Sts. N.W. Washington 25, D. C.	Evaluation of materiel and supplies and testing for standardization. Note: Development functions for the Research and Development Division, OTSG, are performed by Development Branch (Army Staff), Armed Services Medical Materiel Standardization Committee.
Transportation Corps	Commanding Officer Transportation Research and Development Command Fort Eustis, Va.	Contracts for all types of research and development over which the Transportation Corps has cognizance.
Basic Research	Chairman, Army Research Committee Office of the Chief of Research and Development Department of the Army Washington 25, D. C.	Inquiries and proposals concerning basic research.

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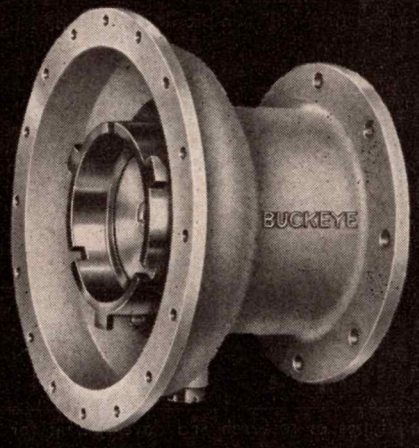

These adapters, now in use, provide the most efficient form of connection for single point fueling ever developed. Note particularly these features:

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Company Small Business Liaison Official of Army Prime Contractors are contained in the booklet previously mentioned, Figure 7.

• • Procurement Information and the Small Business Program

There are several means by which a prospective bidder may obtain up-to-date information on Army procurements.

The "Synopsis of U. S. Government Proposed Procurement and Contract Awards" is published daily by the Department of Commerce and distributed to its field offices and a number of other cooperating agencies throughout the country, such as banks and Chambers of Commerce, where it is available for reference. Copies may be obtained by subscription from the U. S. Department of Commerce, Field Service Administrative Service Office, 433 West Van Buren Street, Chicago 7, Illinois. Part I of the Synopsis provides a list of unclassified proposed procurements in excess of $10,000, both formally advertised and negotiated, which may be suitable for small business firms, including name and address of the purchasing office, brief description of the item, quantity to be purchased, and date when bids or quotations are due. Part II of the Synopsis furnishes information on awards of unclassified prime contracts in excess of $25,000, including brief description of each item, quantity, dollar amount of the contract, and name and address of the firm awarded the contract.

Bulletin boards are maintained in purchasing offices where copies of current Invitations for Bids and Requests for Proposals are posted. In many cases, Invitations for Bids and Requests for Proposals are also distributed to field offices throughout the country.

Copies of Army and Air Force proposed procurements, as well as abstracts of award, are also available for reference at the Army-Air Force Procurement Information Center, Room 332, Old Post Office Building, Washington 25, D. C. Similar information on procurements by Navy activities in Washington, D. C. may be obtained directly from the Navy purchasing offices.

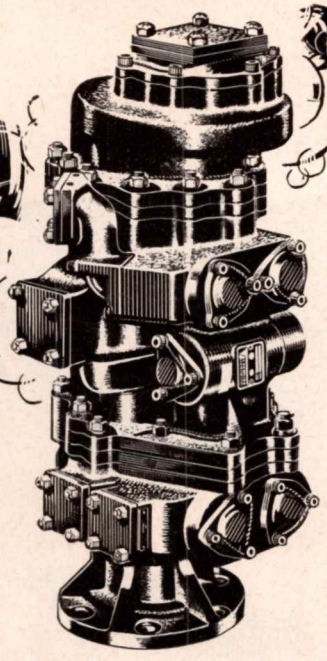
Small Business policies of the Department of Defense are developed by the Small Business offices of the Office of the Secretary of Defense and the three Military Departments in cooperation with the Small Business Administration and other Government agencies whose activities affect the Small Business Program. The ultimate objective is to assist small business in securing its fair share of defense procurement and thereby comply with the policy of the Congress, "that a fair proportion of the total purchases and contracts for supplies and services for the Government shall be placed with small business concerns." (Armed Services Procurement Act of 1947, Public Law 413, 80th Congress.)

"A small business concern for the purpose of Government procurement is a concern that (1) is not dominant in its field of operation and, with its affiliates, employs fewer than 500 employees, or (2) is certified as a small business concern by SBA."

Contracts for research and development projects are awarded by the individual technical services of the Army as listed in Table 3. ◆◆

Way up where

Bubbles mean Troubles...



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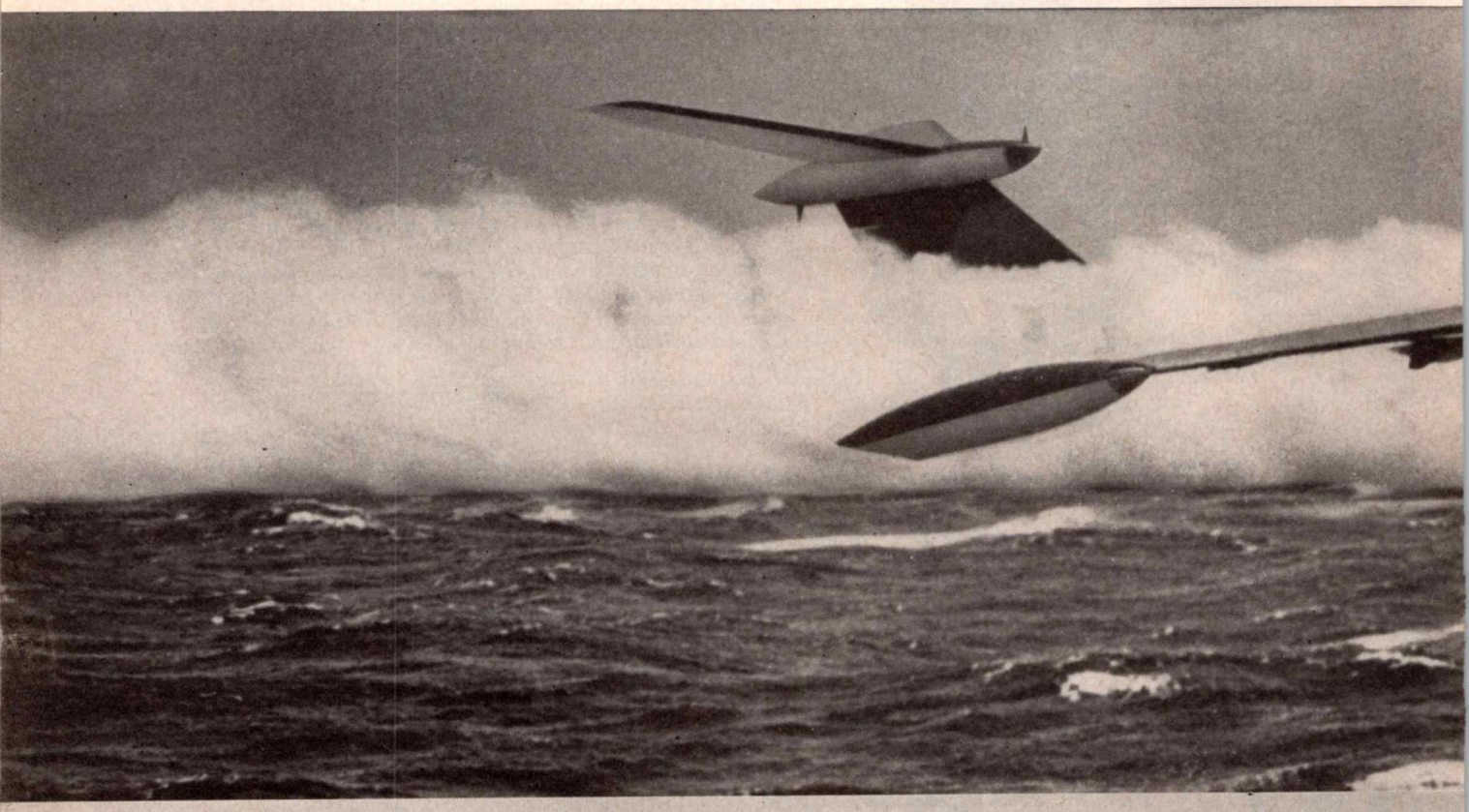
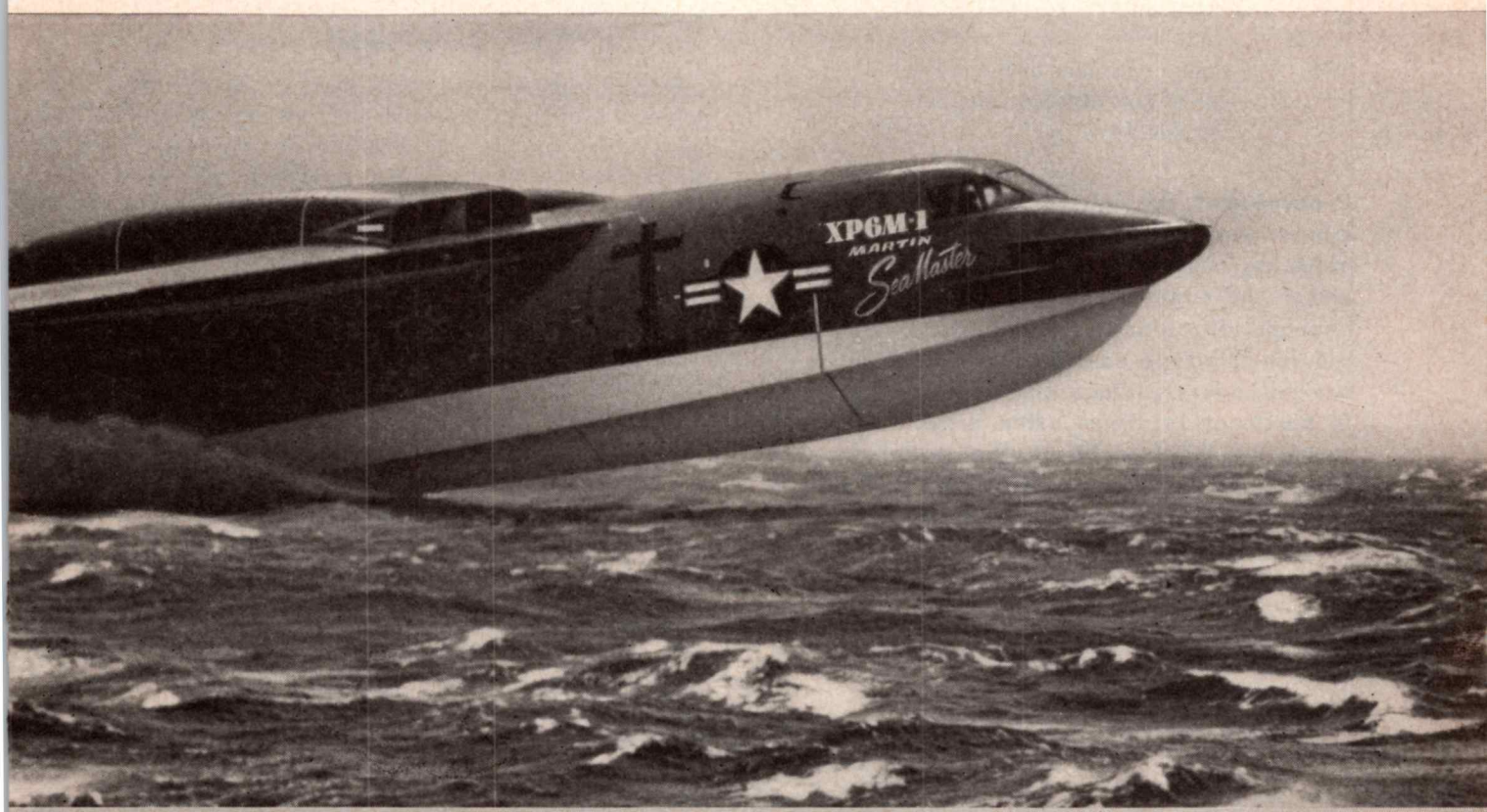


This is one of the most important and exciting aircraft in the world. It is the new Martin SeaMaster, the Navy's first multi-jet attack seaplane. It is now in production and soon to be in fleet service as the spearhead of a powerful new arm of the naval arsenal—the Seaplane Striking Force. The SeaMaster's importance is a matter of inevitability: It is in the over 600 *mph* class, with a normal cruise altitude of 40,000 feet, an unrefueled combat radius of 1,500 miles, and is operable in "Sea State 3" (waves averaging 6 feet) with a payload of 30,000 pounds. Thus, the endless runways of this world's oceans, lakes and estuaries provide unlimited and indestructible bases for SeaMaster operation, making it the first aircraft of any type having global striking power, independent of fixed installations. *For virtually the whole of our habitable world is within flight minutes of open water!* This new aircraft development is another powerful reason why the U. S. Navy offers to the military enlistee one of the most exciting futures in the world today.



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Cost Estimating from THE LEARNING CURVE

THE LEARNING CURVE is based upon the theory that if the quantity on a given contract is increased, the labor required is reduced in some proportion to the increase in quantity.

This theory has been satisfactorily reduced to an equation that is the slope of a straight line on log log paper, which gives a specific reduction in the cumulative average labor-hours per part each time the quantity is doubled. Thus, if we have an 80 percent learning curve, then whenever the quantity is doubled, the cumulative average unit time for all units produced would be 80 percent of the time per part of the initial quantity. It would seem that at some extreme quantity the unit time would become zero. However, a graphical check shows that the quantity approaches infinity faster than the unit time approaches zero.

The formula for the slope of a learning curve is generally expressed as:

$$S = \log(Y_1/Y_2)/\log(X_2/X_1).$$

where,

S = slope or tangent of the curve.
Y = cumulative average unit time.
X = the quantity.

Procurement specialists and contract administrators are vitally concerned with the changing cost of an engineered item when either the contract quantity or the design changes. The learning curve is a powerful aid for this type cost prediction, but in its use misunderstandings and occasional rifts in customer relations often arise. To help overcome these problems, the authors present the basic fundamentals of the learning curve and draw upon their experience for its application to specific cases.

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C. W. McQUEEN
Estimating Consultant
Los Angeles, California

This formula is, in the writer's opinion, too laborious for general use. However, the same results can be obtained by mechanical means as explained in the following paragraphs.

A simple method used for arriving at the slope of the learning curve for actual figures can be used in almost all cases and all that is needed is a sheet of log log paper and four known factors from the accounting department as follows:

A = quantity of parts on the first run.
B = cumulative average hours per part of quantity A above.
X = total quantity of parts completed to date.
Y = cumulative average hours per part of quantity X above.

Locate points AB and XY on a sheet of log log paper and draw a line between them. Then read off the factor C corresponding to a quantity twice quantity A. Then,

(C/B) = percent learning curve.

Since the above curve was determined by only two points, it is often good practice to check this calculated curve as data on future lot quantities become available in the cost department. In fact, it would be poor business practice to attempt to predict costs until several points have been established, thereby giving a definite pattern along a given curve.

To arrive at a unit time or a cumulative average time for various quantities with a known or estimated percent curve, we find that the mechanical method is the simplest and fastest. Let,

A = total quantity.
B = cumulative average hours at A above.
C = unit hours at A.
D = percent learning curve.

Then, the cumulative average hours for $\frac{1}{2}$ A above would be B/D, and unit hours for $\frac{1}{2}$ A would be C/D.

Now, draw a line through points $(\frac{1}{2}A)$ and (A). Extend this line as far as needed to cover the desired quantity. Read off the cumulative average hours or unit hours for the desired unit or quantity.

If you need unit hours and have only cumulative average hours, then multiply the cumulative average hours by the factors corresponding to the learning curve, as shown in Table 1. To obtain cumulative average hours from unit hours, divide by these factors.

• • Establishing the Correct Curve

In the foregoing paragraphs, we have set forth the basic formula for the learning curve. However be-

fore this can be used properly, a method for establishing the correct slope must be devised.

At present the most practical method depends upon the skill, experience and judgment of the estimator. However, a thorough understanding of the basis for these curves is necessary, and with this in mind, we set forth the following points:

1) The learning curve is based upon the human element (man's ability to learn and improve through repetitive operations plus the elimination of direct thought-process movement through repetition).
2) The natural process of methods improvement by the operator and his foreman.
3) More efficient material handling, transportation, pallet moving and so forth.
4) Less percent loss owed to scrap, rejection and reworks.

With the fact that the learning curve is based upon the human element, it would follow that the less manual labor involved the less slope to the curve. For a completely automatic operation such as an automatic screw machine, the curve would be 100 percent; and for a complicated hand assembly, the curve might be as low as 60 percent.

The learning curve for a given assembly would then depend upon a curve for each type of operation and its corresponding percent of the total unit labor; for example:

Machining = 40% of the labor with a curve of 100%;

Punch press = 10% of the labor with a curve of 90%;

Burring, sanding and handforming = 20% of the labor with a curve of 80%;

Assembly = 30% of the labor with a curve of 70%.

Thus, the percent of the labor times the percent of the curve equals 86 percent, or the learning curve for this particular part. Expressed in a formula:

X = % of the labor for each operation expressed in decimal form.

Y = % curve for each operation expressed in decimal form.

C = the learning curve expressed in decimal form.

Therefore: $(X_1)\,(Y_1) + (X_2)\,(Y_2) + (X_3)\,(Y_3) + \ldots = C.$

• • Estimating with Standard Hours

One of the problems of estimating is establishing a consistent method of varying standard hours on estimates, based on the quantities involved. Some firms use the setup-plus-unit-run-time method regardless of quantity; however, this method is usable only when the run time is controlled by the machine as in automatic screw machine or production stamping work. A method more adaptable to most manufacturing is the unit-factor method. This is the method explained below.

In establishing standard times for various operations, it is necessary to select a production quantity at which these standards are valid. In this report the standards are based on the time to produce the 10,000th unit and by multiplication with the unit factor are raised or lowered in relation to the quantity on the order. The value of the unit factor used depends on two variables: the quantity of parts or assemblies, and the slope or percent curve selected. The lower the percent curve selected, the higher the time allowances per unit in quantities of less than 10,000. As an example, the unit factor for 100 units on an 80% curve is 6.4 (see Figure 1), while the unit factor for a 90% curve is 2.35. You will note from these figures that although the unit factor curve is calculated from the unit times (unit 10,000 equals 1), the factors are taken from the cumulative average line.

The use of this system has two definite advantages for estimating: the standardization of times by removing personal opinions of the estimator, and the establishing of a method of controlling the estimate by management without becoming involved in changing time standards or other technical data. The system also develops into a comprehensive cost control program after the job has been received.

• • Intermittent Production

A factor taken from the learning curve based only upon the total quantity on order is generally used in the aircraft industry, and any increase in the total

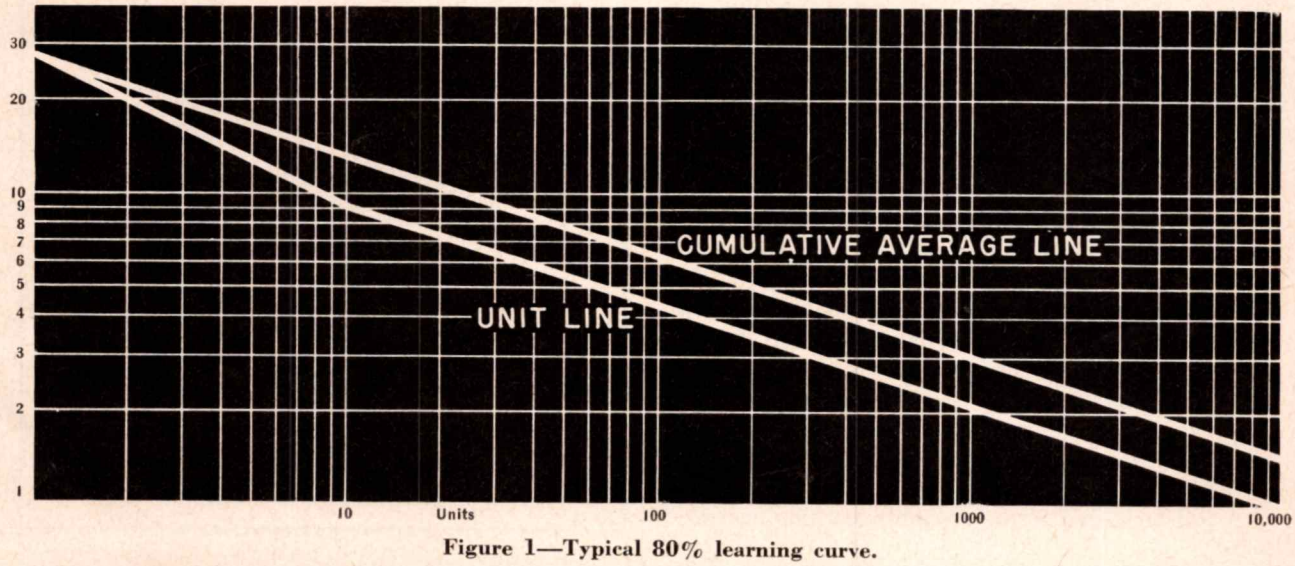


Figure 1—Typical 80% learning curve.

Learning Curve

quantity is expected to bring about a reduced price without consideration for the schedule of the average lot size. This is not always correct and it is not unusual for an increased quantity at the last part of a contract not only to have no effect upon cost but also in extreme cases, to bring about an increase in the unit cost of each part. The factors affecting this point on a given learning curve are:

1) Total contract quantity.
2) Number of increments, lots or runs.
3) Time lapse between runs.

Assuming that standard hours are used and that the accumulative average is based upon unit one at 10,000, we could establish the following formula for use on a scheduled order:

X = total quantity.
Y = scheduled number of lots or increments.
A = learning curve factor for total quantity.
B = learning curve factor for the average lot run.

Step (1): divide X by Y to obtain the average run quantity.

Step (2): obtain the factors corresponding to A and B from the learning curve.

Formula: $[(B-A)/10]+A=$ Factor F.

Example:

$X = 1000, Y = 10$.
$(X/Y) = 100$.
Read corresponding factors from curve to establish:
$B = 6.5$ and $A = 3.1$.
Hence, 3.44 × standard hours = actual hours.

Time lapse between runs has a decided effect upon the end formula; however we do not yet have a suitable method for calculating its effect upon the end cost.

● ● Engineering Changes

It is readily understood that an engineering design change adversely effects operating efficiency with respect to any given assembly. However, the actual cause and effect is rather vague to most administrative personnel.

In order to understand better this effect, consider the following points:

1) Design changes that effectively stop production on a given article are equivalent to adding an additional lot or increment to a given contract.
2) Design changes on a given part where the change results in a different size, configuration or operation necessitates a return to Unit One on that portion of the direct labor hours affected on that part's specific learning curve.
3) Design changes on a detail part, which in turn affect the assembly, returns that equivalent portion of the labor on the assembly to the equivalent Unit One on the assembly learning curve.
4) Design changes affecting tolerances, hole patterns, or dimensional changes only slightly have a minor effect on the learning curve.
5) That portion of the part or assembly affected by the design change contains an efficiency equivalent to that quantity produced prior to the change.
6) That portion of the part or assembly altered by an engineering change can achieve only that efficiency corresponding to the quantity of parts remaining on order.
7) The engineering design changes may also add additional labor, operations or material.

Taking the above seven points into consideration, we can arrive at the following formula:

A = standard hours affected by design change.
B = additional standard labor hours necessitated by design change.
C = quantity produced prior to design change.
D = quantity remaining to be produced after design change.
E = cumulative average factor on the learning curve
F = cumulative average factor on the learning curve corresponding to the parts remaining on order.
G = cumulative average factor on the learning curve corresponding to the total quantity on the contract.

Then,

$$[AEC + (A + B)FD - AG(C + D)]/D = L.$$

Table 1—Learning Curve Factors

Unit Factor Table

(To obtain the unit time at any given unit, multiply the cumulative average time at that unit by the factor opposite the applicable percent curve used.)

LEARNING CURVE %	FACTOR
95	0.926
94	0.911
93	0.895
92	0.880
91	0.864
90	0.848
89	0.832
88	0.816
87	0.799
86	0.782
85	0.766
84	0.748
83	0.731
82	0.714
81	0.696
80	0.678
75	0.585
70	0.485

where L = additional labor required to compensate for the engineering change.

Let H = cumulative average direct labor hours required per part on the contract prior to the engineering change. Then $(H + L)$ = direct labor hours per part required on the balance of this contract to compensate for added engineering change.

Example:

5000 units total contract.
Unit No. 1000 effective point of change.
Use 80% learning curve.
6 hours = direct labor standard hours per part prior to change.
4 hours = direct labor standard hours effected by change.
0.1 hours = additional standard labor hours as a result of the change.
4000 = Quantity of parts to be produced to the latest change.
The 80% factor for 5000 = 1.9.
The 80% factor for 1000 = 3.15.
The 80% factor for 4000 = 2.0.
(6) (1.9) = 11.4 = Actual direct labor hours per part based on 5000 units;

finally, from preceding equation,

$$\frac{(4)\,(3.15)\,(1000)+(5)\,(2.0)\,(4000)-(4)\,(1.9)\,(5000)}{4000} = 13.25,$$

which equals the actual hours required per part on the balance of the contract to compensate for the design change. The additional material, tooling and rework will be added as additional cost.

● ● Cost Control

It is necessary for management to be able to determine at the time of any release whether labor efficiency is improving along a given curve and to advise production of the direct labor hours allowable for each release.

In order to do this, standard hours can be multiplied by a factor for each release to give the cumulative average direct labor hours per part, job or operation.

Assume for cost control purposes that the standard type operating sheets are used; one column would contain Standard Hours and one column would contain the Allowable average hours per operation for any one release. A more economical method of cost control with regard to indirect labor requirements would be to apply the increment cumulative average unit labor hours by part or assembly, and have the accounting department report to management on the basis of completed assemblies instead of on the basis of detail parts or operation. This would allow the use of an average curve instead of different curves for each cost center or operation, thereby reducing the cost of these reports and allowing for a high degree of evaluation and control. This curve would be established by the methods previously outlined, either by an average for the total contract or more accurately by cost center or operation.

We can now establish the release factor (F) for any given release by the following formula:

X = cumulative average factor for the total quantity previously released.
Y = cumulative average factor for the total quantity released plus the quantity on the lot release under consideration.
A = total quantity released.
B = the quantity of the lot to be released.

Now,

$$[(A+B)Y - AX]/B = F$$

Example: 500 parts released and an additional lot of 100 to be released. Use 90% curve. Thus,

$$X = 1.85,\ Y = 1.8,\ A = 500,\ B = 100.$$

Hence,

$$\frac{(500+100)\,(1.8) - (500)\,(1.85)}{100} = 1.55 = F$$

Multiply 1.55 times standard hours to obtain cumulative average allowable unit hours per operation or cost center for this release of 100 pieces; or by use of an average curve the method could be applied to the completed assembly instead of the detail parts or operations.

This information supplied to management showing unit hours used as against unit hours allowed will immediately show which contract, job or operation requires immediate method study, evaluation and/or price adjustment.

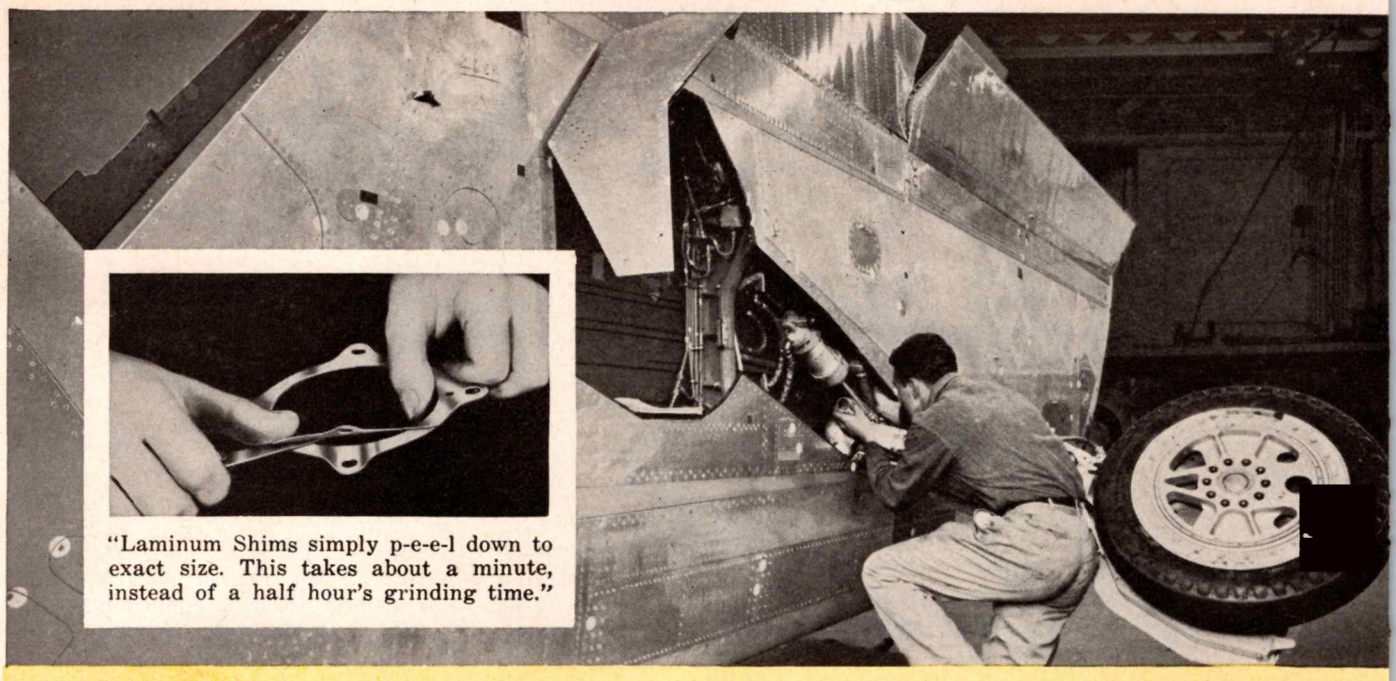
● ● Use of the Curve

We have shown that the learning curve is a function of the complexity of the part, labor involved, tooling and equipment used, design changes during production, and ratio of the total quantity to the average lot run. Thus, we conclude that,

1) The learning curve can be applied only to the labor involved on any one item and cannot be generally applied to material, purchased parts or total price.
2) A specific curve should be calculated for each assembly or part, and that a standard curve applied generally is erroneous.
3) An increase in total contract quantity does not necessarily reduce the direct labor costs, and conversely, a reduction in total contract quantity does not necessarily increase direct labor costs.
4) For price estimating, the learning curve can be used to adjust the price for different quantities only if the same tooling and equipment is planned for all quantities. Any change in tools and equipment changes direct labor hours without respect to a given curve and will also tend to change the slope of the curve.
5) The effect of in-process design changes on total contract cost can be calculated from the learning curve.
6) The learning curve can be used as a method for determining production efficiency at any point in the contract.

Reference

Raborg, W. A., Jr., *Mechanics of the Learning Curve*, AERO DIGEST, November 1952.



"Laminum Shims simply p-e-e-l down to exact size. This takes about a minute, instead of a half hour's grinding time."

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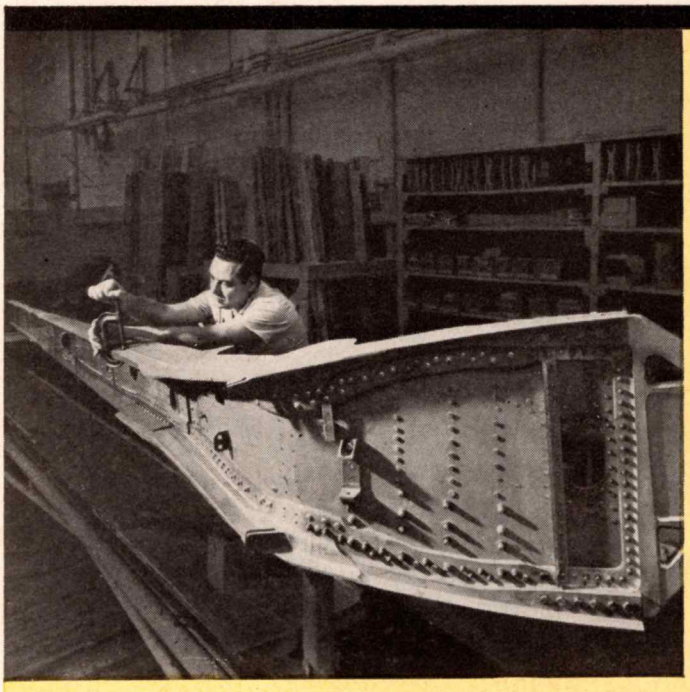

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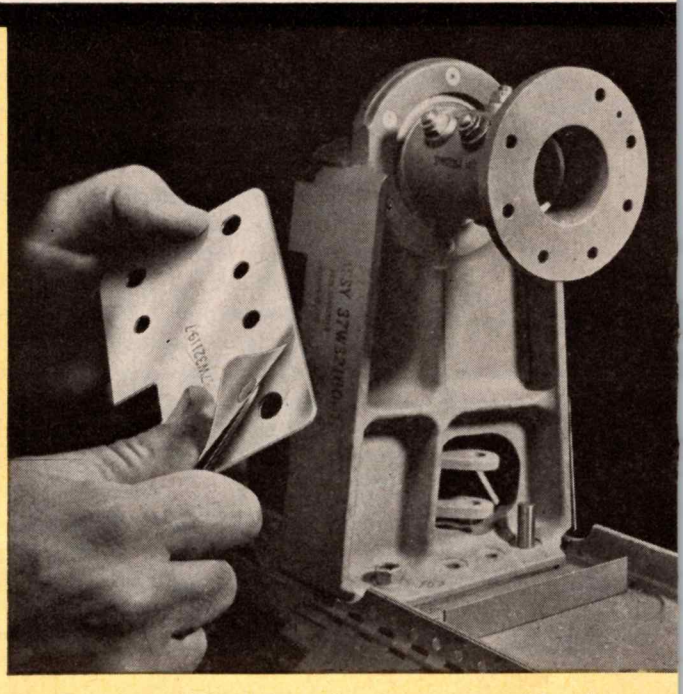

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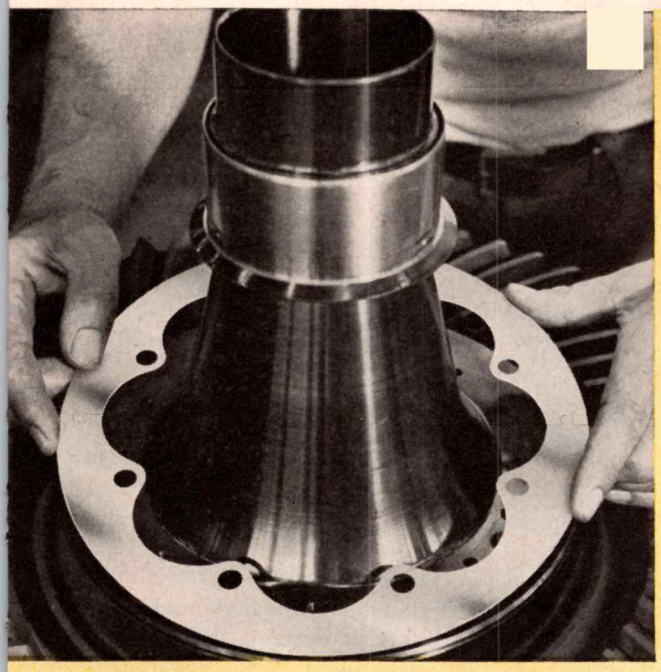

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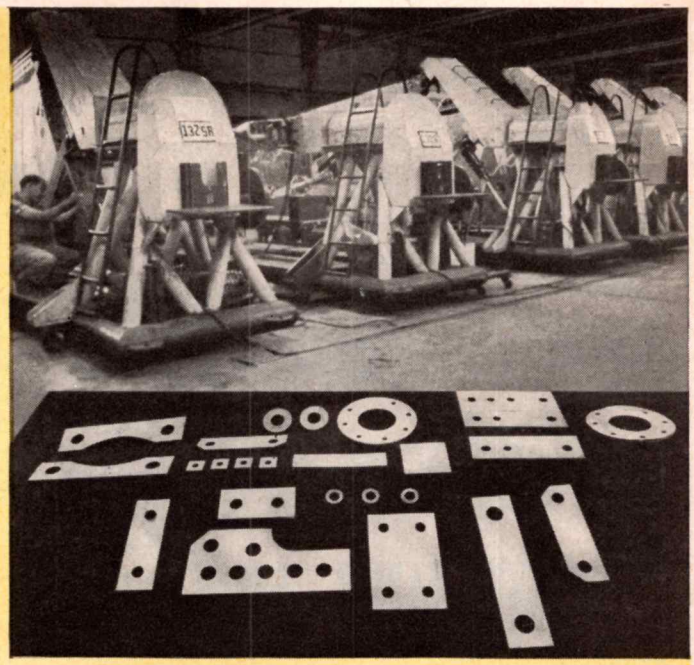

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Aeronautical Engineer
U. S. Coast Guard
Washington 25, D. C.

Factors for Determining the OPTIMUM USE OF MAINTENANCE MANPOWER

For future procurement of aircraft, the U.S. Coast Guard is considering including as a contractural obligation the calculation of aircraft manning data. One method of presenting such data is discussed. Criticisms of the theory or the method are desired and should be directed to the author.

THE U. S. COAST GUARD in common with other organizations, is interested in efficient use of its manpower. The problem of proper manning of Coast Guard aircraft has been a thorny one. Methods developed by other users of aircraft are not directly applicable because of the different aims of the various users.

A common measure of maintenance effort on aircraft is expressed as maintenance man-hours per hour of flight. This parameter is of only limited use to the Coast Guard because it attempts to reduce a variety of variables to one value. Let us examine those operational dimensions that are ignored by the one-dimensional figure of man-hours per hour.

First, there is the number of flying hours per aircraft per year. Military operations concerned with training desire a maximum value of this parameter.

A second dimension in the full operational picture is operational availability. Search and rescue agencies, on call around the clock, desire maximum availability coupled with a certain minimum training level of annual flying hours. This set of requirements never coincides with minimum man-hours per flight hour.

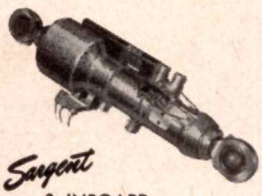
Finally we have commercial flying, whose purpose is to obtain the greatest return per dollar invested. This calls for maximum utilization of the airplane, up to the point where increasing expenses overcome gains from increasing utilization. This will fall at a point determined by flight crew wages, and would be in the general vicinity of minimum maintenance man-hours per hour. The four parameters may be plotted in terms of annual flying hours per aircraft versus availability, with cross plots of crew size and maintenance man-hours per hour of flight. Average daily flight time may also be cross-plotted, if the basic assumption can be made that the airplane is flown every day it is available. The complete plot takes the shape shown in Figure 1. Flying hours per year per aircraft can vary from zero to a maximum of $24 \times 365 = 8760$ hours. Availability runs from zero to 100 percent. Obviously, if availability is zero, flight time must also be zero. For 50 percent availability, flight time cannot be over 50 percent of 8760 hours, and so on. Thus, we can draw a diagonal line from zero to the point 8760 hours and 100 percent availability. Operation is impossible above this line. To construct the curves, we may establish the basic relation as:

$$availability = [365 - (lost\ time)]/365$$

• • Lost Time Factor

Lost time breaks down into the following items:

1) Days lost in periodic inspections of the airplane. This is a function of crew size, up to the point where



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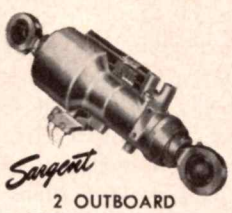

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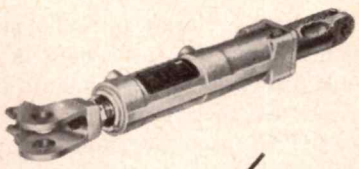

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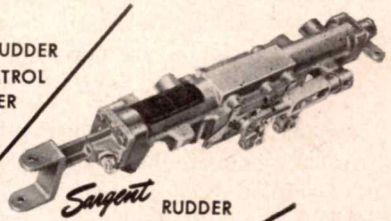

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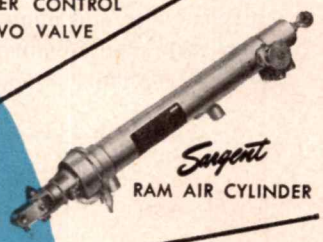

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2 HORIZONTAL TAIL
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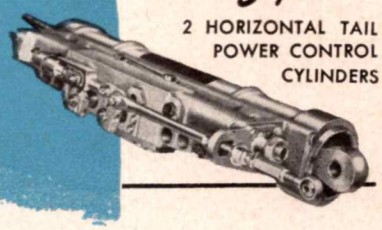
CYLINDERS



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the crew becomes so large as to be unwieldy. The number of man-hours for inspections is usually given in handbooks prepared by the manufacturer, but experience shows that such figures are usually on the low side because of the need for additional man-hours to repair defects disclosed by the inspection. Because the inspections are periodic, they are also a function of annual flying hours.

2) Days lost in routine maintenance of the airplane. This includes those engine changes not made during overhaul or check periods, and incorporation of urgent CAA or military changes. It is a function of crew size, airplane size and annual flying hours. From a practical standpoint, isolated maintenance jobs taking less than 20 minutes may be ignored; practically speaking,

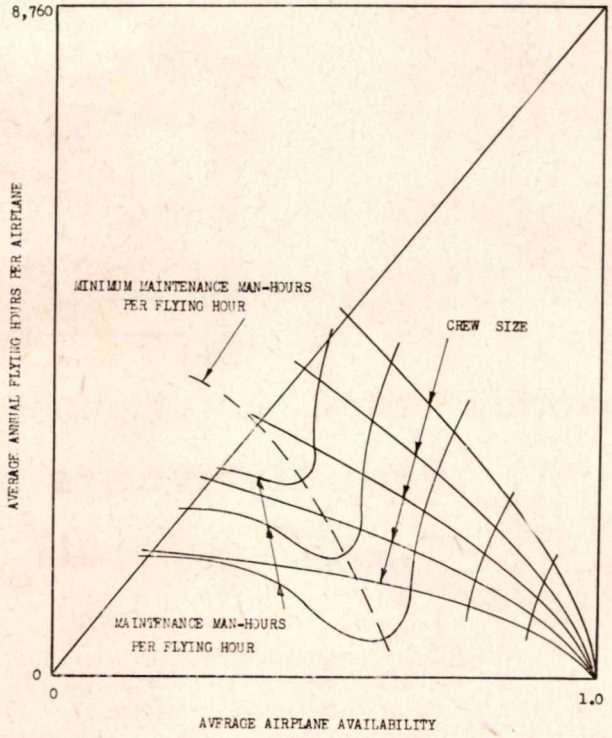

Figure 1—Airplane availability in terms of flying time and crew size.

an airplane that will be ready in 15 or 20 minutes may be considered to be available.

3) Days lost waiting for replacement parts or assignment of maintenance personnel from more pressing duties. This varies with crew size and the local logistic and operational situation.

4) Days lost on weekends when no work is done on the airplane. With large crews, few days need be lost; with high values of flying time, the airplane is apt to come due for periodic inspection over a weekend, so that this factor is a function of crew size and flying time.

Summing up, we have an equation expressing availability for a given airplane in terms of flying time and crew size. We can plot the equation as a family of curves of varying crew size, against flight time and airplane availability, as in Figure 1. Cross plots of maintenance man-hours per flying hour can now be made, using the flying hours directly from the basic plot, and assuming perhaps 2000 working hours per year per crew member. A line of optimum use of maintenance personnel may also be drawn in; see the dashed line in Figure 1.

● ● Probability Criteria

For operations requiring maximum profit or maximum training, crew utilization will fall near the optimum, but for search and rescue operations requiring high availability, crew utilization is obviously poor. For search and rescue operations, the question arises as to whether it is more economical to operate a few aircraft with large crews and high availability or many

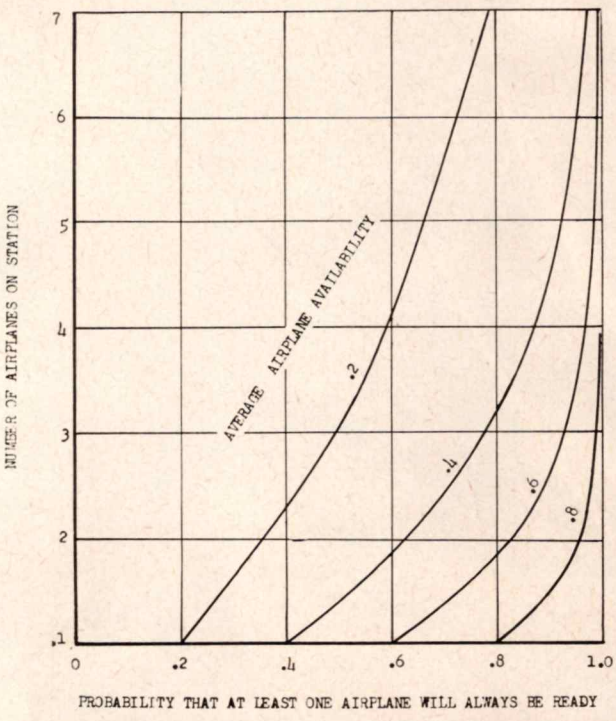

Figure 2—Probability that an airplane will be available for immediate use.

aircraft with small crews and low availability. The deciding factor is the probability that can be accepted that at least one aircraft will be ready at any given time. This probability must, of course, be high. The equation expressing the probability is:

$$P = 1 - (1 - a)^n, \text{ where}$$

P = probability that at least one aircraft will be ready.
n = average availability of the aircraft.
n = number of aircraft.

This expression has been plotted in Figure 2. It can be seen that the low-availability aircraft require relatively large numbers to maintain acceptably high probabilities. By working between Figures 1 and 2, knowing crew pay scales and airplane costs, the most economical numbers of aircraft and crew size may be determined. ◆ ◆

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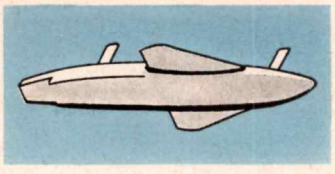

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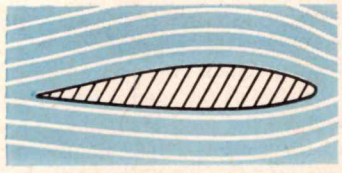

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Jet-Induced CIRCULATION CONTROL

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Prof., U. of Paris; and Director
Lab. of Elect. Analogy, O.N.E.R.A.

PH. POISSON-QUINTON
Aerodynamic Res. Group Leader,
O.N.E.R.A., Paris

P. JOUSSERANDOT
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O.N.E.R.A., Paris

(Adapted from the original by G. Boehler, Dept. of Aero. Eng., Catholic U. of America, Wash., D. C.)

One of the critical military problems is to procure high-speed aircraft having short takeoff and landing characteristics. Of high interest, particularly to the Navy for carrier-based planes, and to the Army where terrain plays such an important part, is the recently developed theory of circulation control. Dominant in this work are the French aerodynamicists (of O.N.E.R.A.) whose studies equal and perhaps surpass those of the British.

The present series of three articles is intended to acquaint engineers in the U. S. with the work of these aerodynamicists with respect to the theory and application of circulation control to STOL aircraft. In this study, circulation control is achieved by means of a full-span blowing jet of variable orientation located at or near a wing's trailing edge.

Part I, which gives an introduction to circulation control, appeared in the September 1956 issue of AERO DIGEST. The present part, Part II, presents the theoretical development and test results. Part III, scheduled for the November 1956 issue of AERO DIGEST, deals with the application of circulation control to aircraft design.

PART II—EXPERIMENTAL RESULTS

CIRCULATION CONTROL can be obtained either by suction (sink effect) or by blowing (jet effect).

The theory of the sink effect (Reference 1, Part I) predicts that the lift increase is proportional to the volume flow coefficient and increases in proportion to the distance between the suction slot, located on the upper side, and the trailing edge,

$$\Delta C_L = 2\, C_q \tan^{-1} (\theta_1/2),$$

where θ_1 is the argument of the point corresponding to the slot location on the conformal mapping circle.

The theory is in good agreement with tests: the negative pressures on the top part of the airfoil are increased by suction (Figure 9a), and the local sink effect appears at the neighborhood of the trailing edge; finally the lift increase is proportional to C_q (Figure 9b).

The combination of the sink effect and of the jet effect was tested on a two-dimensional airfoil, and the results show that both effects add linearly (Figures 9b and 9c) and that the pressure distributions look very much alike; in each case the lift increase is proportional to C_q since for blowing, $\Delta C_L = f(\sqrt{C_\mu}) = f(C_q)$ for a given slot width (s/c), where $C_\mu = 2C_q^2/(s/c)$.

● ● Trailing-Edge Blowing

The basic O.N.E.R.A. tests were made on a two-dimensional airfoil mounted between the walls of Saint-Cyr wind tunnel (airfoil chord, about 1 foot; speed between 50 and 100 ft/sec, Reynolds numbers from 0.3×10^6 to 0.6×10^6).

From measurements of the slope of the lift curve of the airfoil without blowing, it was found that the effective aspect ratio was not infinite, but about 20: $(dC_L/d\alpha)° = 0.092$.

A thick airfoil, NACA 0018, was chosen in order to avoid premature flow separation at the leading edge, which would have modified the results at high lift coefficients. No wall corrections were applied.

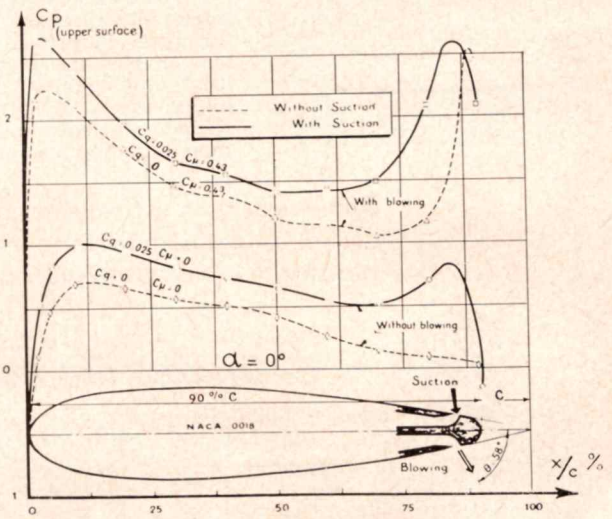

Figure 9a—Pressure distribution over airfoil with circulation control by suction and blowing.

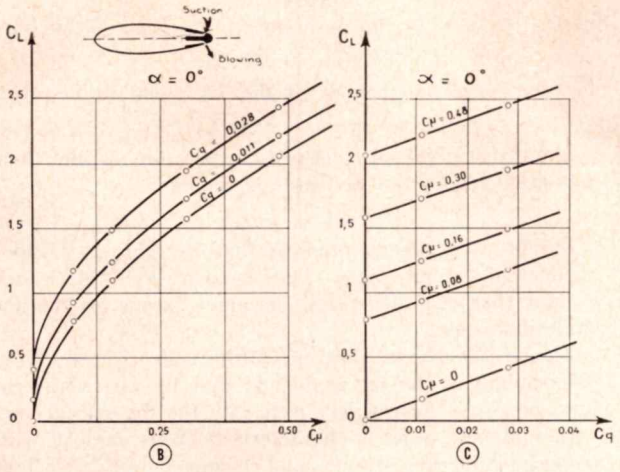

Figure 9b, c—Variation of lift coefficient with combined suction and blowing at the trailing edge.

The greatest experimental difficulty of the blowing tests is in the exact determination of the fundamental parameters: the jet momentum J, and the effective orientation of the jet θ. In principle, J could be determined from the measurement of the mass flow and the calculation of the isentropic velocity V_j. Actually, the small size of the blowing duct makes it difficult to measure the generating pressure and temperature. In addition, at small scale, the discharge losses at the slot are large, causing the actual jet velocity to deviate from the isentropic value. The calculation of J by this method is therefore subject to error.

It seemed better to measure J directly by means of thrust measurements on the model, the measurements being made in the wind tunnel at zero airspeed. This method has the advantage of also providing the effective jet angle, θ.

The force R_B measured on the balance is the sum of the jet reaction R_j and of the reaction induced on the airfoil R_i. R_j results from the change in pressure distribution on the airfoil caused by the blowing jet, and its components can be obtained by integrating the pressure distribution. Resolved into its components, R_B is given by the vector relation:

$$\vec{R_B} = \vec{R_J} + \vec{R_i}$$

Finally, the magnitude of the jet reaction is calculated from,

$$J = \sqrt{R^2_{Lj} + R^2_{Dj}},$$

and the jet angle is given by,

$$\tan \theta = R_{Lj}/R_{Dj}$$

The subscripts L and D indicate lift and drag components, respectively.

In all tests under consideration, the induced reaction is zero for two values of the jet angle ($\theta = 6°$ and $\theta = 64°$ approximately) and reaches a positive maximum for θ equal to 45° (then the ratio of the induced to the total reaction R_i/R_r is equal to 0.4). It is negative for θ smaller than 6° and for θ larger than 64°.

By means of the calibration curve obtained with the wind tunnel at zero speed, J can be related to the measured mass flow. The momentum coefficient is defined as:

$$C_\mu = J/(\rho/2)U^2S$$

where U is the tunnel speed, and S is the actual wing area.

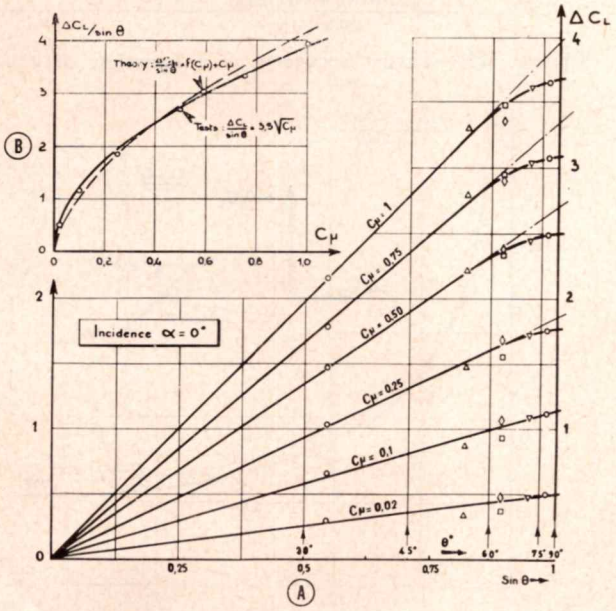

Figure 11—Influence of blowing jet orientation on the lift increase.

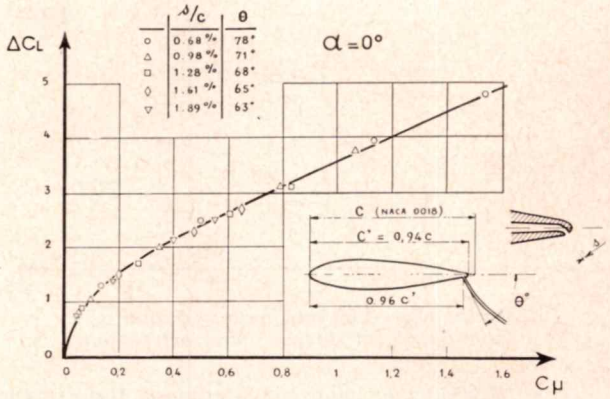

Figure 10—Influence of blowing slot width on lift increase.

● ● Influence of Slot Width

The study of the influence of the slot width was made for a given position of the slot, located at 96 percent of the leading edge (airfoil truncated at 94 percent of the theoretical airfoil), and for a geometric orientation of the jet of 90°. Tests showed that the effective jet angle differed from the geometric orientation, and that the discrepancy increased with the slot width because of the imperfect guiding of the jet at such a small scale.

The tests were made for slot widths (s/c) between 0.68 percent ($\theta = 78°$) and 1.89 percent ($\theta = 63°$); the effective jet angles θ were determined from tests at zero airspeed as described above.

Figure 10 shows that the variation of lift increase as a function of C_μ is independent of the slot width, since all experimental points fall upon a universal curve. This justifies the choice of C_μ as the basic blowing parameter.

The influence of the jet angle was studied for slots located 97 percent behind the leading edge (airfoil not truncated at the trailing edge).

Figure 11a shows that the lift increase is proportional to sin θ for a given momentum coefficient as long as the

angle θ is smaller than about 65°; for larger angles and at large values of C_μ, a decrease in the slope of the lift curve is noted.

The slope of the curves of variation of ΔC_L against sin θ as a function of C_μ is in good agreement with that predicted theoretically, as shown in Figure 11b. For the range of C_μ of the test, the experimental curve satisfies the equation,

$$\Delta C_L = 3.9 \sqrt{C_\mu} \sin \theta$$

This leads to the notion of specific lift increase ($\Delta C_L / \sqrt{C_\mu} \sin \theta$).

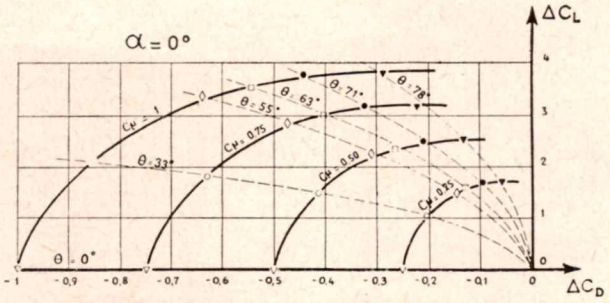

Figure 12a—Lift and drag variation as a function of jet intensity and orientation.

It is interesting to follow simultaneously the variation of lift and drag at zero angle of attack with variations of C_μ and θ; this is provided in Figure 12a.

For $\theta = 0°$, the decrease in drag is equal to the increase in thrust represented by the coefficient C_μ; the thrust decreases as the jet angle increases; part of the drag that appears then is induced drag, since the aspect ratio is not infinite, strictly speaking. In order to determine the amount of net thrust resulting from blowing, we subtracted from the measured drag increase due to blowing (ΔC_{D_B}) the effective induced drag of the wing resulting from the lift increase ($\Delta C_L - C_\mu \sin \theta$). It was assumed, therefore, that the induced drag resulting from the blowing effect at zero angle of attack has an expression similar to that of the induced drag resulting from the effect of angle of attack with no blowing. This hypothesis would need further justification, but it is believed to give an order of magnitude of value for the induced drag. It can be expressed in mathematical terms as follows: for the test conditions, the equation of the polar curve of the airfoil without blowing is,

$$C_D = C_{D_o} + 0.036\ C^2_L$$

The net increase of drag, including the blowing effect, is therefore calculated to be,

$$\Delta C_{D_N} = \Delta C_{D_B} - 0.036\ (\Delta C_L - C_\mu \sin \theta)^2$$

● ● Thrust Recovery

Figure 12b shows the thrust recovery ($-\Delta C_{D_N}/C_\mu$) as a function of C_μ for various jet angles. The recovery is equal to 1 for $\theta = 0°$; it decreases when the jet angle increases, but the net thrust is always much larger than the horizontal component of the momentum of the jet ($-C_\mu \cos \theta$). In the most unfavorable case, $\theta = 63°$,

$$-\Delta C_{D_N} = 0.8\ C_\mu$$

The horizontal component of the jet alone would give,

$$C_\mu \cos \theta = 0.45\ C_\mu$$

The thrust obtained from tests is therefore smaller than that predicted by the perfect-fluid theory:

$$-\Delta C_{D_N} = C_\mu$$

Besides, the theory predicts that the thrust is independent of the jet angle. Tests indicate that this is not so and that the thrust loss becomes larger as the jet angle increases.

Figure 12c shows that the lifting effectiveness E is independent of the jet angle and that its variation as a function of C_μ agrees very well with the theoretical one.

In summary, a jet is characterized by its angle θ with respect to the free stream, and its momentum coefficient C_μ. It is interesting to compare its use as an isolated jet, to its use as a distributed blowing source at the trailing edge of a wing. For $C_\mu = 1$ and $\theta = 55°$, the comparison is shown in Table I.

In conclusion, the aerodynamic balance seems favorable for a blowing wing applied to an airplane designed for very short take-off and landing.

It must be noted, however, that trailing-edge blowing results in a nose-down pitching moment, which must be balanced at the cost of a loss in lift, while an isolated jet can rotate around the center of gravity of the airplane without creating a parasitic pitching moment. However, this is only true with a conventional tail. For the tail-first

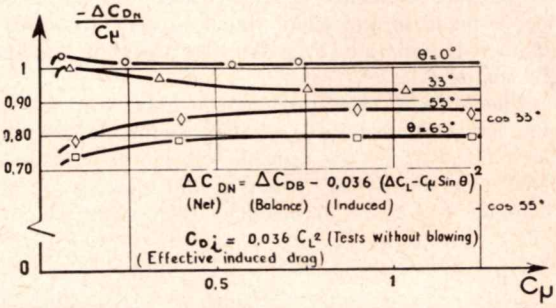

Figure 12b—Thrust recovery as a function of C_μ.

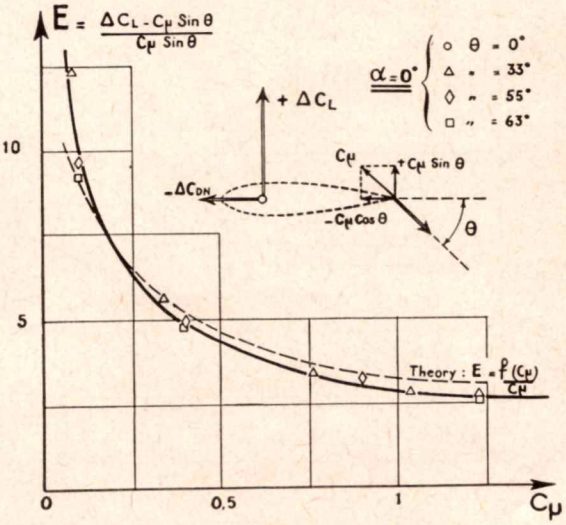

Figure 12c—Lifting effectivness as a function of C_μ.

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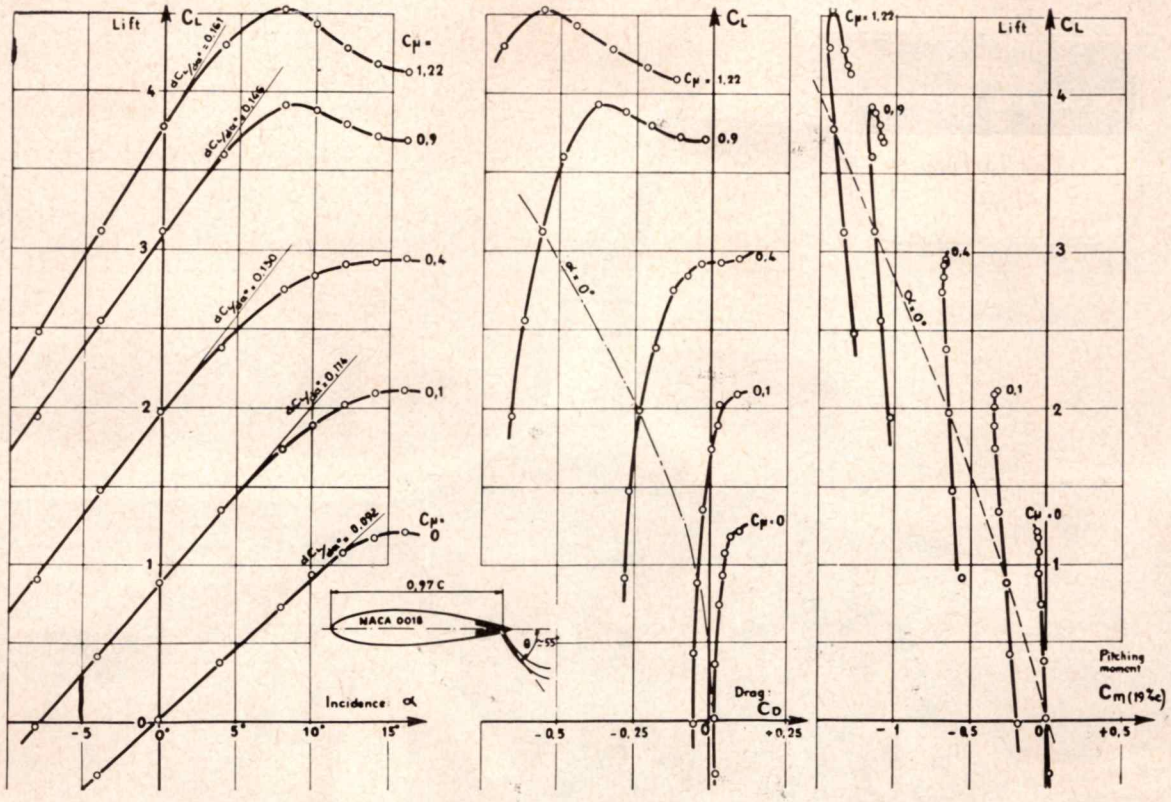

Figure 13—Variation of lift, drag and pitching moment with angle of attack.

or canard airplane the balancing lift of the tail adds to the wing lift instead of subtracting from it; in addition, the lift of the tail can also be obtained by blowing.

● ● Thrust Wing at Angle of Attack

The results of the tests shown in Figure 13 are for an NACA 0018 airfoil with a jet angle $\theta = 55°$ and various values of C_μ. Note that the slope $(dC_L/d\alpha)$ increases with C_μ; the angle of attack for maximum lift decreases when C_μ increases. One must realize that in these tests no wall corrections were applied. They would correspond to an increase of effective angle of attack and a decrease of the slope of the lift curve. The polar curves (C_L, C_D) are shifted towards negative drags by an amount smaller than C_μ, but much larger than $C_\mu \cos \theta$, as was seen above; the curves of longitudinal stability (C_L, C_M) are shifted in the direction of negative (diving) pitching moments, and the static stability margin increases slightly.

Table I—Characteristics of isolated jet compared with those for trailing-edge blowing. $C_\mu = 1$, $\Theta = 55°$. (Values for trailing-edge blowing obtained from two-dimensional tests.)

	Isolated jet	Trailing-edge blowing	Gain
C_L = net lift coefficient	$C_\mu \sin \Theta$ $= 0.82\ C_\mu$	$3.2\ C_\mu$	$\frac{3.2}{0.82} = 3.9$
C_D = net drag coefficient	$-C_\mu \cos \Theta$ $= -0.57\ C_\mu$	$-0.87\ C_\mu$	$\frac{0.87}{0.57} = 1.5$
Resultant $= C_R$ $= \sqrt{C_L^2 + C_{DN}^2}$	C_μ	$3.3\ C_\mu$	3.3

The increase in slope $(dC_L/d\alpha)$ is practically independent of the jet angle and is a function only of C_μ; this is shown in Figure 14, where the curves (C_L, α) are plotted for three values of the jet angle and a common value of C_μ. On the other hand, the angle of attack for maximum lift decreases when θ increases.

Figure 15 shows the variation of the slope of the lift curve and of the center of pressure at zero angle of attack as a function of C_μ, for three jet angles. One can see that: the slope $(dC_L/d\alpha)$ is independent of θ and increases by 57 percent between $C_\mu = 0$ and $C_\mu = 1$; the center of pressure is located at 50 percent of the chord as soon as one starts blowing (classical flap effect), and moves aft as the blowing increases (by 6 percent for $C_\mu = 1$).

In summary, the location of the center of pressure is independent of the jet angle and changes little with blowing; the nose-down pitching moment therefore increases proportionally to the lift, therefore proportionally to $\sqrt{C_\mu}$.

● ● Trailing-Edge Blowing for Low Aspect-Ratio Wings

The tests described up to now were made on a thick, pseudo two-dimensional airfoil, which corresponded to a wing of high aspect ratio, around 20.

Further research was made for wings of finite aspect ratio, with planforms and thickness corresponding to those actually used for high-speed aircraft. The main object of this research was along the following lines:

1) Study of longitudinal balance.
2) Effect of airfoil thickness.
3) Effect of wing sweepback.
4) Compressibility effects.

Tests were made in the 10-foot O.N.E.R.A. wind tunnel at Cannes on a model of a complete airplane ($U = 75$

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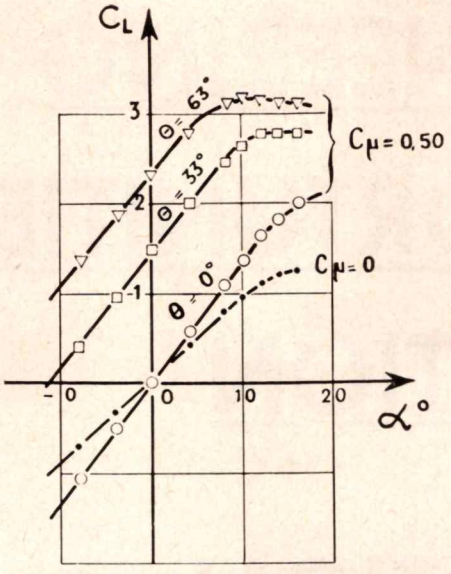


Fig. 14—Effect of jet orientation on lift variation with respect to angle of attack.

ft/sec, $Re = 0.85 \times 10^6$). The object of the study was to find out the effects of trailing-edge blowing for an airplane with a straight wing of aspect ratio 3.

The blowing air was brought into the model by a hose going through one of the supports of the three-component (lift, drag, pitching moment) balance.

The coefficient C_μ and the jet angle θ were determined in the same manner as for the two-dimensional tests. All coefficients were referred to the total wing area and the actual wing chord. The airfoil was symmetrical, 4.25 percent thick. The blowing slot, located on the lower surface of the airfoil, just ahead of the truncated trailing edge, could be oriented at the angles $\theta = 90°$ or $\theta = 29°$. The slot extended along the whole span of the straight wing, of aspect ratio 3, on each side of a fuselage which is a body of revolution. The area of the wing blanketed by the fuselage was 22.5 percent of the total wing area, which was taken as the reference area.

A movable horizontal tail, with a vertical location lower than that of the wing, allowed a study of the longitudinal trim and of the downwash at the tail for the airplane with blowing. The tail volume was equal to 0.465. Finally, tip tanks could be mounted at the tip of the wings in order to increase the effective aspect ratio.

The physical limitations of the blowing installation did not permit attainment of high values of C_μ (the maximum C_μ was about 0.2). However, the lift increase at a given angle of attack is a linear function of $\sqrt{C_\mu}$, and the results could therefore be extrapolated.

At zero angle of attack and for $\theta = 90°$, the lift increase of the tailless airplane without tip tanks is given by:

$$\Delta C_L = 1.6 \sqrt{C_\mu}$$

The addition of tip tanks results in an appreciable increase of the effective aspect ratio ($dC_L/d\alpha$ increases by 30 percent) and the blowing effectiveness is increased:

$$\Delta C_L = 1.9 \sqrt{C_\mu}$$

Figure 16 summarizes the aerodynamic characteristics of the airplane, for $\theta = 90°$, with and without blowing. In the configuration (wing plus fuselage), the curves (C_L, α) of Figure 16a indicate an increase of the slope ($dC_L/d\alpha$) with blowing; the angle of attack for maximum lift remains practically unchanged, which is very remarkable for such a thin airfoil. Visualization of the flow with nylon tufts glued on the upper surface indicated the existence of a fairly surprising type of flow: at $\alpha = 10°$ and $C_\mu = 0.18$, for example, the flow over the wing appears to be completely separated aft of the leading edge; however, the lift keeps increasing proportionately with the angle of attack. In fact, the separated zone in the immediate neighborhood of the upper surface is limited by a streamline which goes around the upper surface and meets at the trailing edge the blowing jet sheet. The reattachment by induction in the neighborhood of the trailing edge is clearly evidenced by the tufts.

Therefore, the flow around a wing with trailing-edge blowing is basically different from that around a wing with conventional high-lift devices.

● ● Longitudinal Control

The longitudinal balance of the complete airplane by means of a deflection of the horizontal tail results in a sizable loss of lift ($\Delta C_L = -0.2$ for $C_\mu = 0.18$ at $\alpha = 10°$), but it does not reduce the angle of attack for maximum lift.

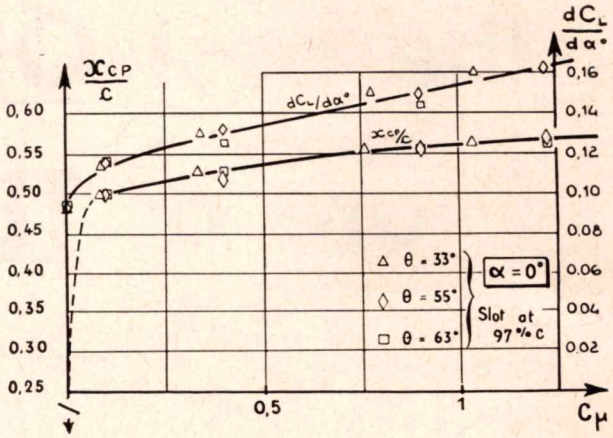
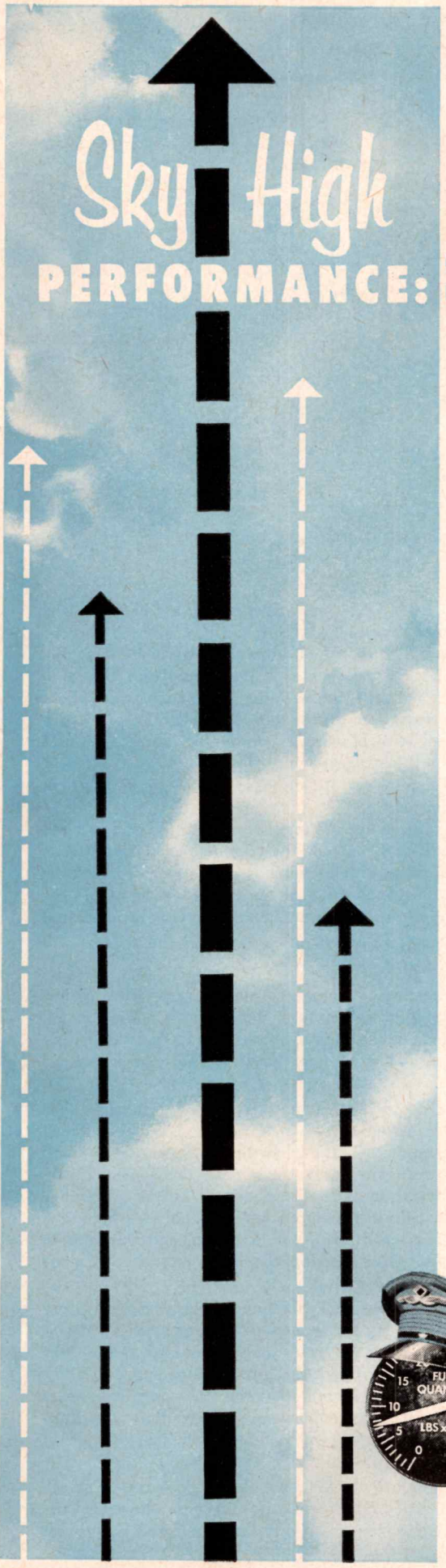


Figure 15—Slope of lift curve and center of pressure variations with C_μ for various jet orientations.

The polar curves (C_L, C_D) of Figure 16b show that, at a given C_L, as a result of blowing the drag is lower, but the balance is not favorable, because of the large jet angle ($\theta = 90°$).

The curves of longitudinal stability (C_L, C_M) of Figure 16c for the configuration (wing plus fuselage) indicate a global shift of the curves towards negative pitching moments and a greater linearity of the moment curves with blowing. The static stability margin of the complete airplane with c.g. at 20 percent chord goes from 6.5 percent without blowing to 11.4 percent for $C_\mu = 0.18$.

Figure 17b shows the variation of the lifting effectiveness as a function of C_μ. For $\theta = 90°$, the lifting effectiveness is increased by the presence of the tip tanks. For the airplane with tip tanks, the lifting effectiveness increases when the jet angle decreases. Therefore, too high a jet angle is detrimental and, as in the two-dimensional case, it is not worth while to use jet angles larger than about 60°. Beyond this value, the lift does not increase proportionally with sin θ and the loss of momentum in the thrust direction becomes appreciable.



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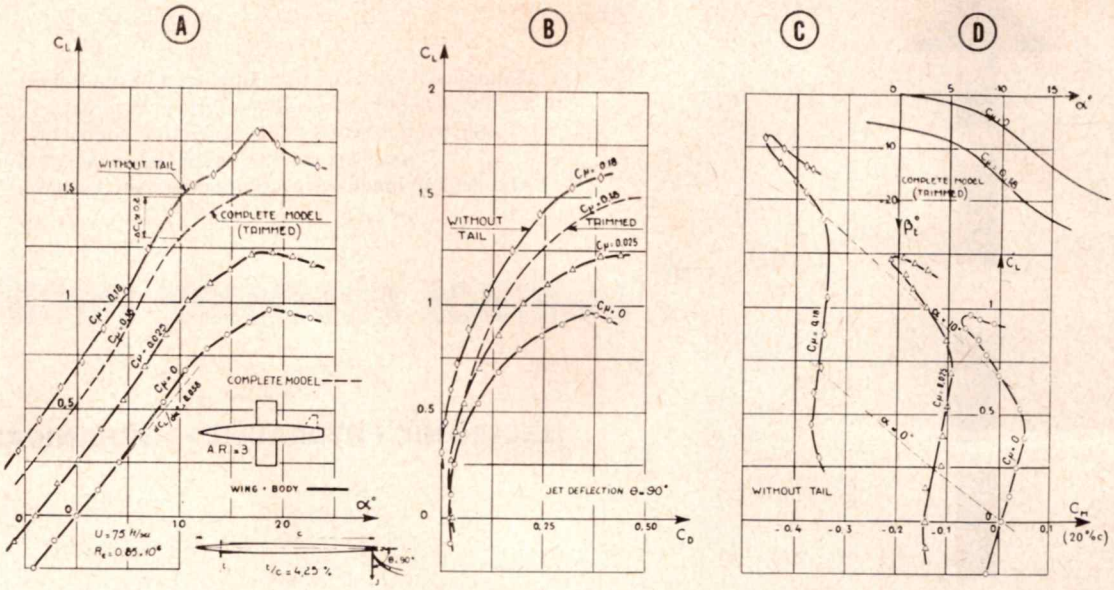

Figure 16—Aerodynamic characteristics of a small aspect ratio airplane with trailing edge blowing.

For example, for the airplane with tip tanks, compare the specific lift increase for the following values:

$$\text{for } \theta = 90°,\ \Delta C_L/(\sqrt{C_\mu}\sin\theta) = 1.9$$

$$\text{for } \theta = 29°,\ \Delta C_L/(\sqrt{C_\mu}\sin\theta) = 2.4$$

• • Trailing-Edge Blowing for a Delta Wing

Tests were made by O.N.E.R.A. in the sonic wind-tunnel at La Courneuve on a half-model (mounted on a wall balance) equipped with a supply of compressed air.

The initial delta wing, with a 60° sweepback at the leading edge, was equipped with a 6 percent symmetrical airfoil. In order to provide for a constant-thickness blowing slot, the wing was clipped spanwise and chordwise. As a result, the aspect ratio was very small, 1.42. The effective jet angle, $\theta = 70°$, was determined as before. The Reynolds number was $Re = 1.4 \times 10^6$ at a Mach number of 0.3. The maximum Mach number of the tests was 0.93. Because of the small scale of the model and the high speed of the test, the C_μ was small (C_μ maximum, about 0.1). The variation of the aerodynamic characteristics of the model with blowing is similar to those previously reported for the straight wing.

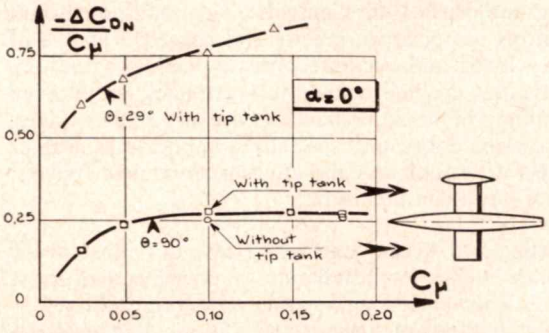

Figure 17a—Thurst recovery as a function of C_μ, small aspect ratio airplane.

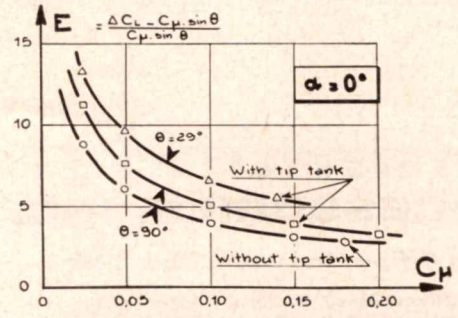

Figure 17b — Lifting effectiveness small aspect ratio airplane.

Figure 18 shows the lift increase at zero angle of attack as a function of C_μ.

Blowing does not change the longitudinal control characteristics (β_t, α) for the trimmed airplane (Figure 16d). The curve with blowing is only displaced towards the negative settings (β_t) of the horizontal tail.

The average downwash at the tail remains proportional to $\sqrt{C_\mu}$ at all angles of attack and has the value,

$$\varepsilon° = 13.6\sqrt{C_\mu}$$

It is interesting to summarize the characteristics of low aspect-ratio blowing as was done for two-dimensional blowing and define again thrust recovery and lifting effectiveness. This is done at zero angle of attack in Figure 17.

Arbitrarily, and as a first approximation, one has assumed again that the laws of variation of the induced drag with angle of attack (without blowing) or with blowing at zero angle of attack were the same. Therefore, the net drag ΔC_{D_N} is obtained as the difference between the drag measured on the balance and the induced drag calculated for a given supercirculation ($\Delta C_L - C_\mu \sin\theta$), using the coefficient of the polar curve without blowing.

Figure 17a shows the variation of the thrust recovery ($-\Delta C_{D_N}/C_\mu$) as a function of C_μ for two jet angles $\theta = 29°$ and $\theta = 90°$, with and without tip tanks. For the angle $\theta = 29°$, C_μ of the tests was too small to allow determination of an asymptotic value; however, it appears that the thrust recovery becomes larger than the horizontal component of the momentum coefficient ($C_\mu \cos\theta = 0.86$) above $C_\mu = 0.2$.

For the angle $\theta = 90°$, the thrust recovery is small, of the order of 25 percent. In this case, however, the horizontal component of the jet thrust is zero. The thrust

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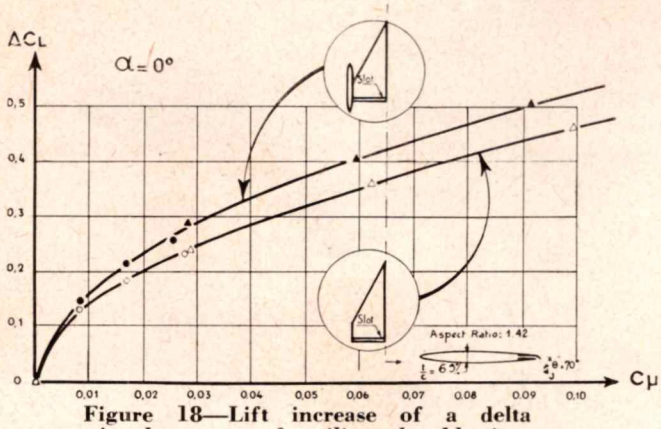

Figure 18—Lift increase of a delta wing by means of trailing-edge blowing.

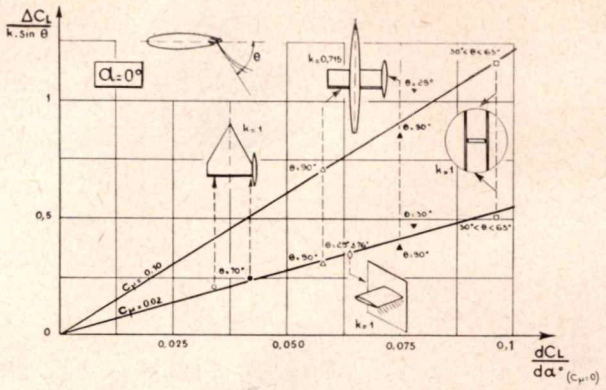

Figure 19 — Influence of aspect ratio on lift increase due to blowing.

recovery is not changed by the presence of the tip tanks.

The addition of a tip tank increases the effective aspect ratio ($dC_L/d\alpha$ increases by 24 percent), and the blowing effectiveness is improved.

The lift varies linearly with $\sqrt{C_\mu}$:

without tip tanks, $C_L = 1.46\ \sqrt{C_\mu}$

with tip tanks, $C_L = 1.64\ \sqrt{C_\mu}$

Because of the large amount of sweepback of the wing, no compressibility trouble was apparent in the range of Mach numbers of the tests. The lifting effectiveness was not affected by compressibility.

● ● Influence of Aspect Ratio

Having presented a certain number of experimental results concerning the application of trailing-edge blowing to wings of very different aspects ratios, we find it necessary to give a rule that will permit an easy correlation with the aspect ratio.

The geometric aspect ratio is not a convenient parameter, since it has no meaning in the pseudo two-dimensional tests and for wing configurations with tip tanks. The least arbitrary method consists in classifying the results in terms of the experimental slope of the lift curve ($dC_L/d\alpha$), which is directly related to the effective aspect ratio.

On the other hand, it is well known that the effectiveness of a conventional flap ($dC_L/d\beta$) is proportional to the slope of the lift curve of the wing to which the flap is applied.

Assuming, therefore, that the fluid flap corresponding to the trailing-edge jet behaves as a classical flap, we see that the lift increase, for a given jet angle θ and momentum coefficient C_μ, will be proportional to the slope of the lift curve measured on the wing without blowing,

$$(\Delta C_{L1}/\Delta C_{L2}) = (dC_L/d\alpha)_1/(dC_L/d\alpha)_2.$$

The spanwise discontinuity of the blowing slot caused by the presence of a fuselage can be accounted for by using the tabular calculations made for classical flaps, References 14 and 15. The lift increase will be reduced, as compared to the wing with full-span blowing, in the ratio,

$$\Delta C_L\ (W+F)/\Delta C_L(W) = k < 1$$

All previous results relative to trailing-edge blowing are summed up in Figure 19 as a plot of ($\Delta C_L/k \sin\theta$) versus $(dC_L/d\alpha)_{C_\mu=0}$ for given values of C_μ, at zero angle of attack. It is remarkable that the points relative to all wings that were tested fall on straight lines, despite the fact that the test conditions were very different (airfoil thickness varying between 4 and 18 percent, Reynolds numbers between 0.3×10^6 and 2.4×10^6, different testing techniques, and so forth). It must be noted that for the airplane of aspect ratio 3 the interruption in blowing due to the fuselage was accounted for ($k = 0.715$) and that the presence of the fuselage does not modify the slope of the lift curve at $C_\mu = 0$, as compared to a wing alone of the same aspect ratio.

These examples are given for very low values of C_μ because of the limitation imposed on the mass flows due to the testing conditions. It is reasonable to believe that the linearity of the curves should persist at higher values of C_μ.

For a first approximation it is therefore possible to use two-dimensional results for the preliminary design of an airplane, for which the slope of the lift curve $(dC_L/d\alpha)_{C_\mu=0}$ and the amount of the span affected by blowing (leading to a coefficient k for a given planform) are known.

In the actual case, $\Delta C_L = 3.9\ \sqrt{C_\mu} \sin\theta$ for $dC_L/d\alpha = 0.092$. Hence, the approximate formula holds,

$$\Delta C_L = 42.5\ \sqrt{C_\mu} \sin\theta\ (dC_L/d\alpha)_{C_\mu=0}$$

In summary, it seems that the lift increase of a wing by trailing-edge blowing can be reasonably well approximated from two-dimensional results. However, experimental evidence on large-scale models for a wide variety of planforms is lacking.

The jet flap behaves approximately as a conventional flap and its effectiveness decreases rapidly at low aspect ratio. (It decreases by about 40 percent for an aspect ratio change between 10 and 3). Every method open to increase the effective aspect ratio (tip tanks, fences, and so forth), therefore, allows a definite improvement of the lift, for a given θ and C_μ.

● ● Influence of Shock Waves on Trailing-Edge Blowing

Tests were made at O.N.E.R.A.'s sonic wind-tunnel at La Courneuve on a straight-wing half-model; the blocking Mach number of the tunnel being $M = 0.91$, the airfoil was chosen rather thick in order to obtain shock waves at Mach number $M = 0.75$, approximately.

The initial symmetrical 10 percent thick airfoil was truncated at 88 percent from the leading edge, to make possible the installation of a blowing slot, oriented successively at the angles $\theta = -2°$, 29° and 76°.

The effective aspect ratio of the wing was 3.4. The average Reynolds number was $Re = 1.5 \times 10^6$.

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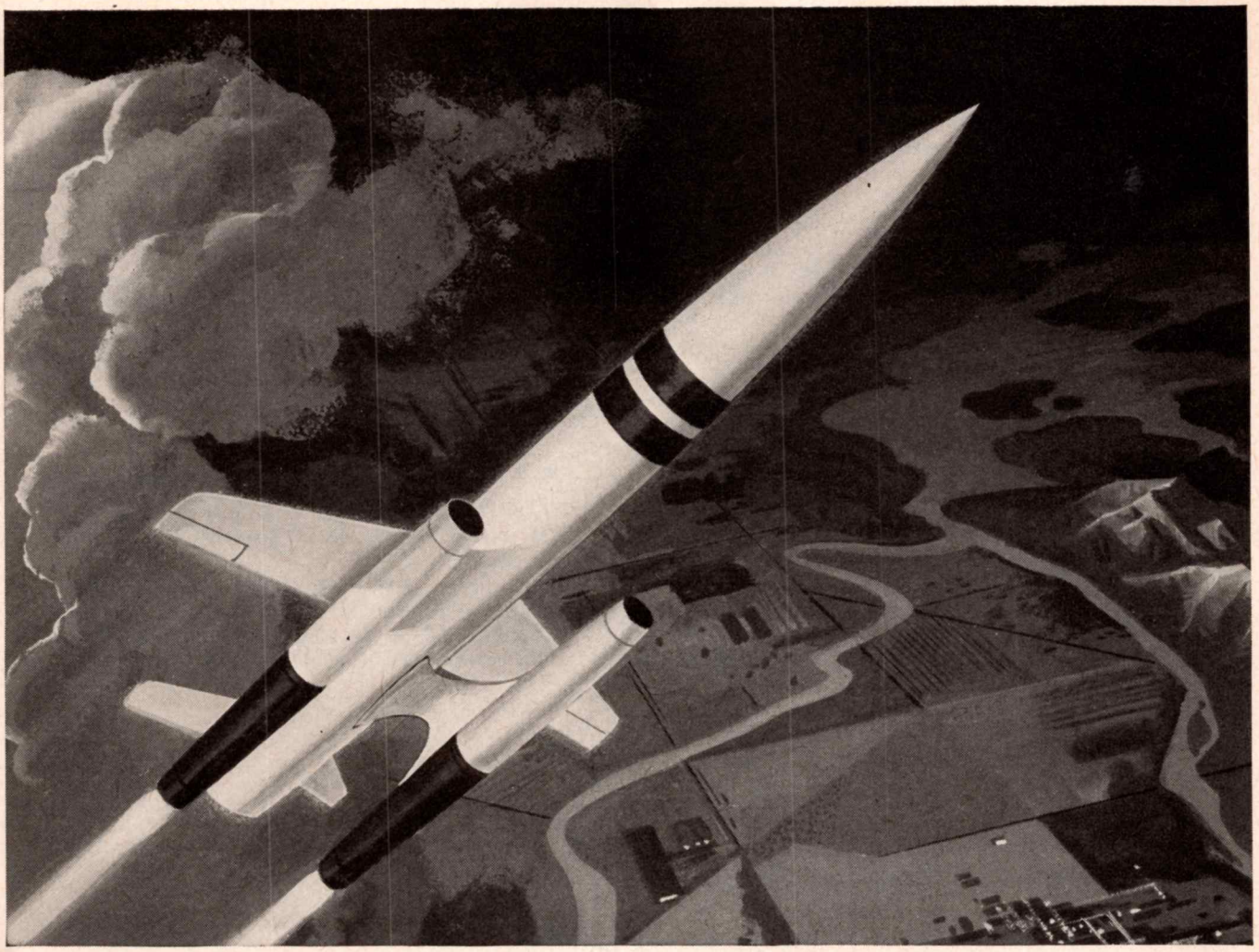

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Because of the high tunnel speeds, the values of C_μ are very small (maximum C_μ around 0.02).

Figure 20 shows the influence of Mach number on lift and drag for a constant momentum coefficient of blowing, $C_\mu = 0.023$, at an angle of attack $\alpha = 3°$.

For the propulsive wing ($\theta = -2°$, approximately), the decrease in lift and the drag rise take place at the same Mach number ($M = 0.85$), with and without blowing; it must be noticed that the decrease in drag coefficient due to blowing is slightly larger than C_μ, because of the improvement of the flow due to the jet at the truncated trailing edge; the propulsive effect is found up to the largest Mach numbers of the tests. Therefore, the presence of shock waves does not disturb the jet propulsion at the trailing edge.

Blowing with a jet angle $\theta = 29°$ results in a lift increase that increases with compressibility (even after the curves fall off around $M = 0.87$), while giving rise at the same time to a propulsive effect despite the increase of the induced drag.

Finally, blowing with a jet angle $\theta = 76°$ results in an appreciable lift increase, which however is influenced by compressibility at $M = 0.84$, while the drag begins to rise at $M = 0.75$.

In general, for a given jet angle θ and blowing coefficient C_μ, the lift increase with Mach number follows well Prandtl-Glauert's classical theory, for a straight wing of aspect ratio 3.4. The lifting effectiveness remains very high since C_μ is very small: $E = 17$ at $M = 0.75$ for $C_\mu = 0.023$. It must be pointed out that at this Mach number the small value of C_μ still corresponds to a large thrust, of the order of 5000 pounds for an airplane with a wing area of 270 square feet, flying at low altitude.

In summary, blowing does not alleviate the troubles caused by compressibility for a given wing, but the lifting effectiveness increases with the Mach number, even in the presence of shock waves. For the same lift increase at a given Mach number, the propulsive wing has a much lower net drag than the conventional wing, the reason being that the circulation increase due to blowing creates a more even chordwise velocity distribution, for a given lift and Mach number, hence a higher critical Mach number.

• • Combination of Flap Effect and Jet Effect

Trailing-edge blowing, as it was described above, is not directly applicable to airplanes for two essential reasons.

1) The jet angle must be controllable during operation of the airplane.

2) A failure in the blowing means a complete loss of the control of the lift of the airplane.

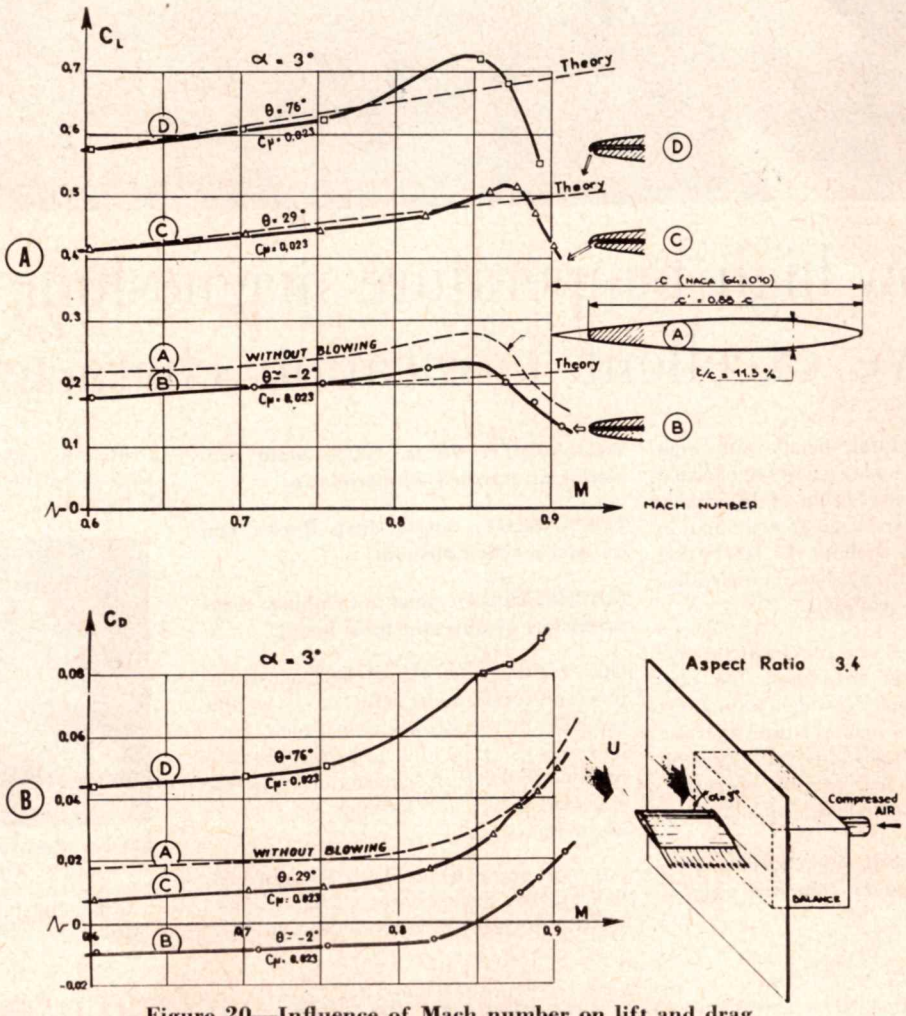

Figure 20—Influence of Mach number on lift and drag variation of a straight wing with trailing-edge blowing.

The simultaneous use of the flap effect and of the jet effect can remedy this situation.

A deflection of the flap results in a change in the jet angle and at the same time contributes to an increase in the lift of the wing; on the other hand, boundary-layer control allows one to maintain an unseparated flow over the deflected flap, the effectiveness of which remains the theoretical one, up to very large deflection angles. Finally, in case of loss of blowing, the flap keeps an effectiveness sufficient to control the airplane.

Prevention of separation of the flow over the deflected flap can be obtained either by suction or by blowing of the boundary layer.

In the first case, suction can be combined with trailing-edge blowing by using ejectors.

In the second case, tangential blowing over the flap ensures the proper flow on the flap, and the jet is automatically oriented by the flap deflection.

Systematic research on both configurations was made by O.N.E.R.A. for a two-dimensional airfoil in incompressable flow, under the same experimental conditions as the previous studies.

References

12. Malavard, L.; Poisson-Quinton, Ph.; and Jousserandot, P., *Jet-Induced Circulation Control, Part I,* Aero Digest, September 1956.
13. Poisson-Quinton, Ph. *Idées nouvelles sur le contrôle de la couche limite appliqué aux ailes d'avion,* Les Cahiers d'Aérodynamique, No. 3, 1946.
14. De Young, J. and Harper, C. W. *Theoretical Symmetric Span Loading at Subsonic Speeds for Wings Having Arbitrary Plan Form,* NACA Report No. 921, 1948.
15. De Young, J. *Theoretical Symmetric Span Loading Due to Flap Deflection for Wings of Arbitrary Plan Form at Subsonic Speeds,* NACA Report No. 1071, 1952.

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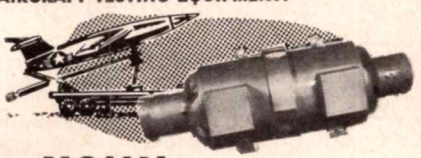

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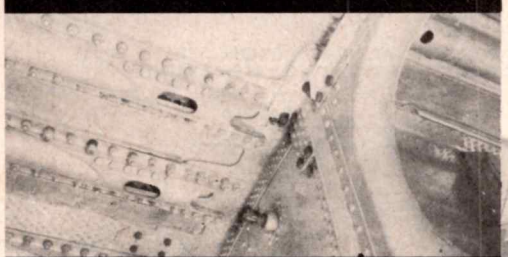

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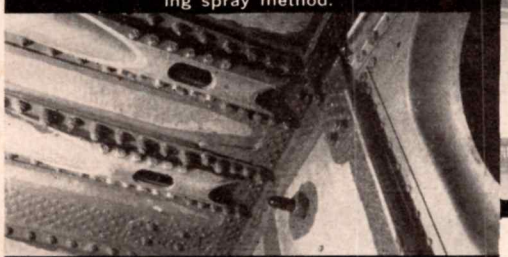

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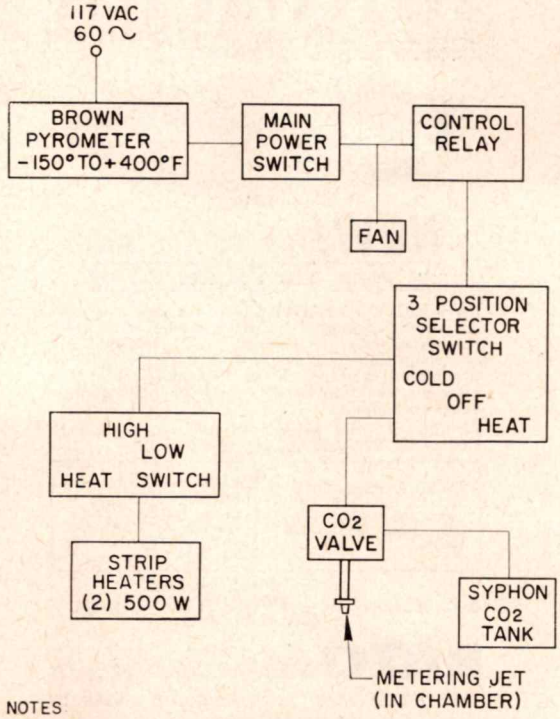
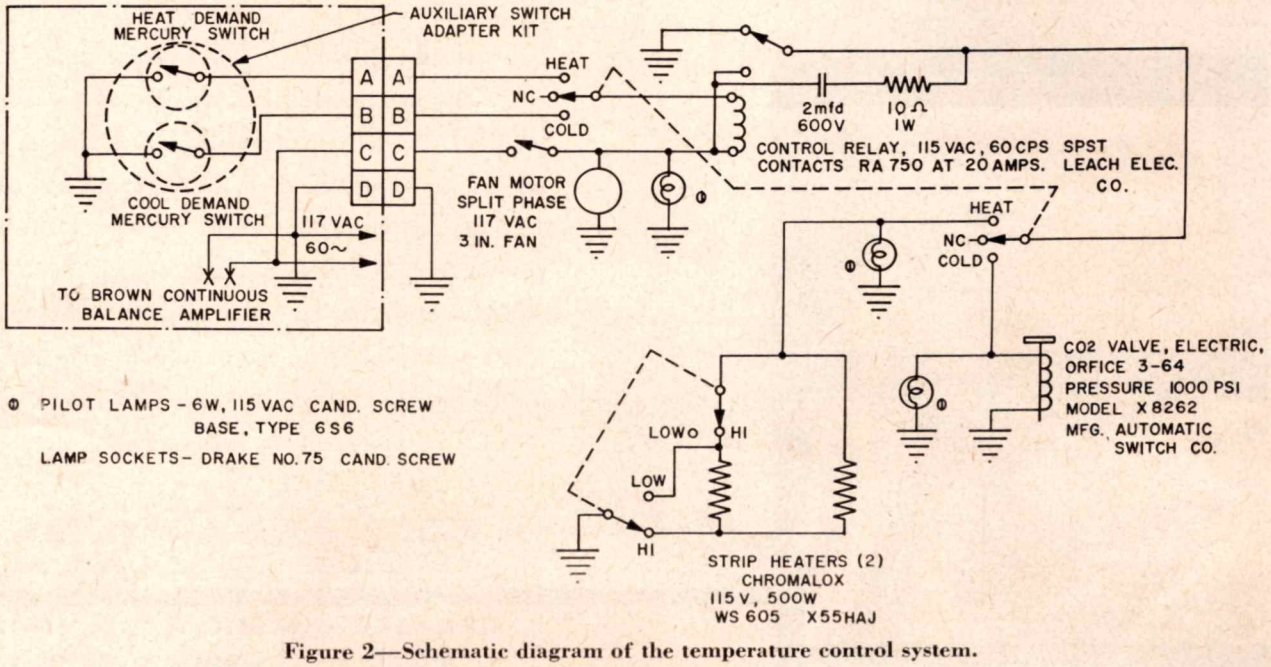


NOTES
MAIN POWER SWITCH & FAN MOTOR MUST BE ON BEFORE OTHER CIRCUITS CAN BE USED.
THE PYROMETER IS USED FOR TEMPERATURE CONTROL. MERCURY SWITCHES MUST BE SET FOR DESIRED TEMPERATURE. HI-LOW HEAT SWITCH WILL SELECT EITHER 250W OR 1000W.

Figure 1—Block diagram of temperature control system.

IT IS FAIRLY ROUTINE to vibrate specimens at room temperatures to establish whether mechanical damage will occur. Though equally important, it is less common to test specimens at all the environmental temperatures that will be met during the life of the specimens.

Through use of a simple mechanism developed by LearCal, it is practical to maintain a pre-selected temperature within a test box within ± 2° over the temperature range of —55° C to +125° C. The means is shown in the block diagram of Figure 1. The basic system consists of using a Brown pyrometer as a temperature-sensing device. This pyrometer includes a



PILOT LAMPS - 6W, 115 VAC CAND. SCREW BASE, TYPE 6S6
LAMP SOCKETS - DRAKE NO. 75 CAND. SCREW

Figure 2—Schematic diagram of the temperature control system.

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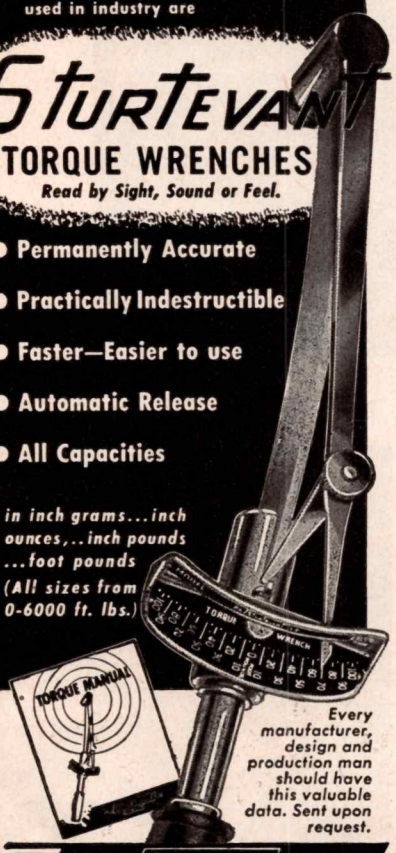

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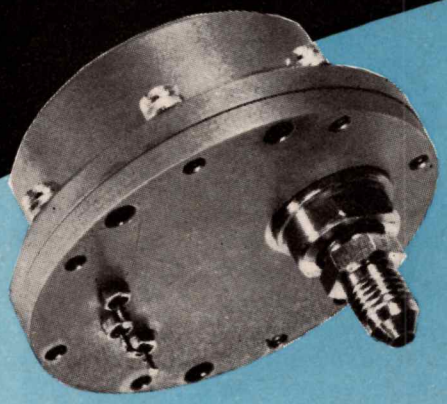
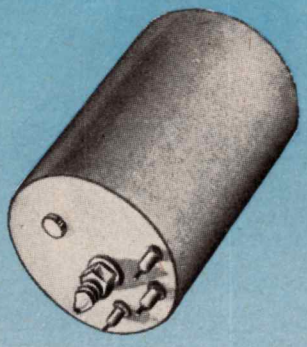


RAHM



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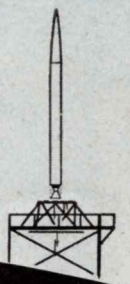

RAHM INSTRUMENTS INC.

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servo system whereby deviations from a selected temperature cause the closing of a pair of switch contacts. These contacts in turn operate a control relay. The control relay in turn operates either a heat control switch or a gas pressure valve which controls the magnitude of CO_2 gas that enters the test chamber. Schematically, the system is illustrated in Figure 2, which identifies the specific components used in the system. It will be found that none of the values or types of components specified will prove to be critical, and a good latitude is available to the constructor of a duplicate device, with a reasonable assurance of satisfactory performance.

The general appearance of the overall arrangement is shown in Figure 3. The control panel for the shaker is shown at the extreme left. Continuing from left to right, we see the CO_2 tank and gauge. The shaker mechanism, with the test box mounted to it, is shown in the center of the figure. The wires connecting to the temperature-indicating and servomechanism device mounted in the rack are shown at the extreme right. The temperature-sensing device occupies only the top 30 percent of the cabinet. The remainder may be used for other types of test equipment.

In Figure 4 we have a close-up of the test box showing the cover removed together with the indicator lights and the control switches. In the center of the cover are the two 500-watt Chromalox strip heaters. Directly to the right of the heaters we see the heat-deflecting baffle plus the fan portion of the blower mechanism. The actual blower motor is housed within the cover proper.

Figure 5 is a view looking down into the test chamber. In this particular case, a small transformer is being prepared for the vibration test. The four sides of the test chamber are attached to conventional vibration isolators, which in turn are attached to the shaker pot. This mounting can readily be seen in Figure 3.

We also see that the transformer is mounted to the test table of the vibration assembly. The four sides of the test chamber are attached to a sheet of neoprene rubber. This permits the necessary freedom for the vertical oscillation of the test table while providing a degree of thermal insulation between the interior of the test box and the exterior ambient air.

This vibration device has been in service for over a year and has given most satisfactory service. ◆ ◆

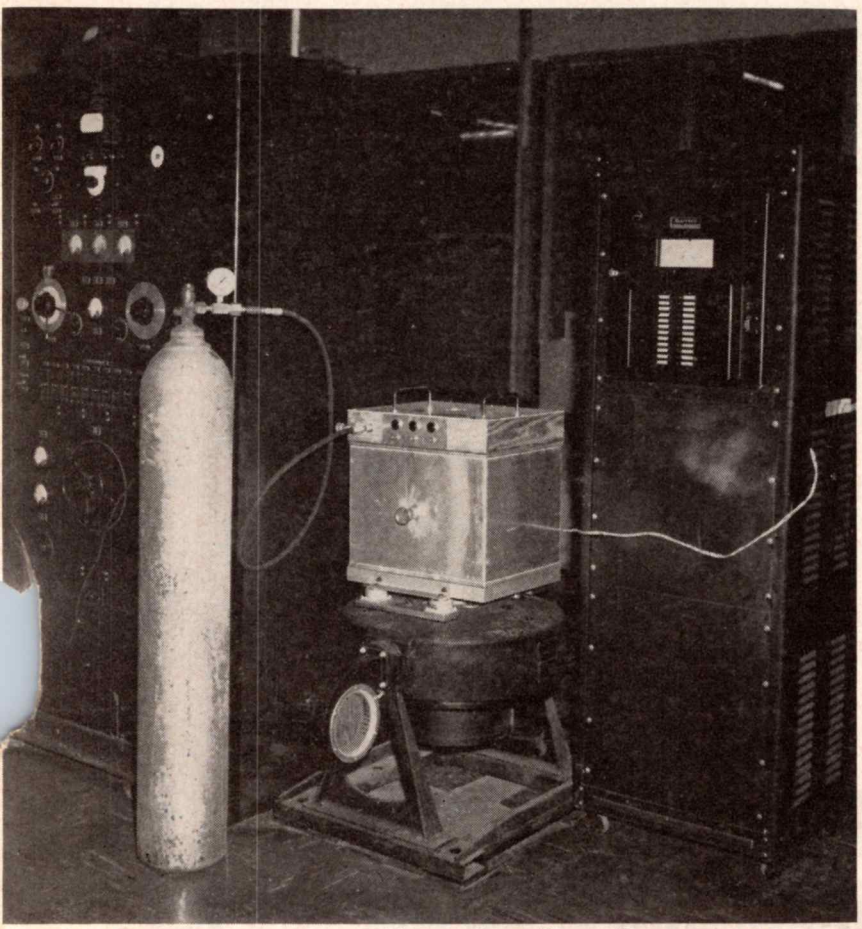


Figure 3 — View illustrating the actual equipment in the environmental laboratory.

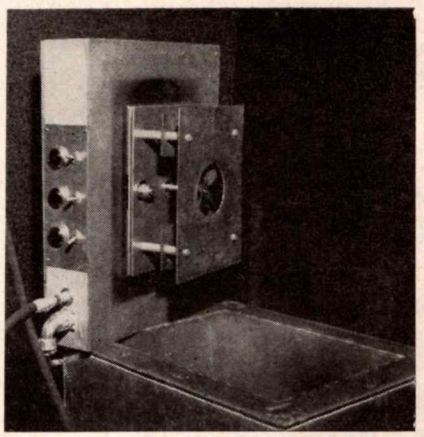


Figure 4—View of test-box cover revealing strip heaters, blower and control switch assemblies.

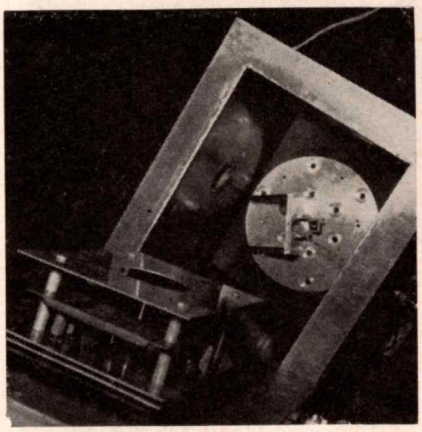
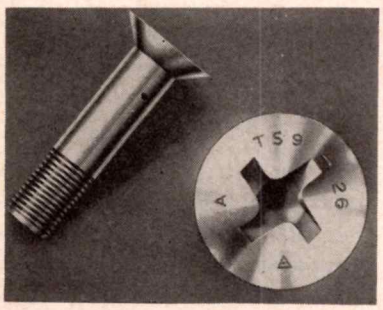


Figure 5—View looking downward into test box.

new equipment

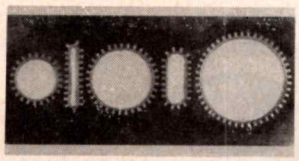
For further information use Reader Reply Card on Page 81.

Helicopter Blade Tracker. Chicago Aerial Industries, Inc. has developed and manufactured an electronic blade tracker, an electro-optical device that determines, either on the ground or in the air, the tracking position of any blade in its flight path in the same plane of rotation. Unit weighs 34 lb and requires no attachments to be made on any of the blades. Company says instrument will track from 120 to 1500 rpm with an observation rate as high as 80 blades per second. (E-1)



Aircraft Fastener. American Screw Company has announced a basically new principle for aircraft fasteners. Called Torq-Set, new fastener features a recessed design that permits power driving and tightening to higher torques than ever before available, according to the manufacturer. The wings of the recess have parallel sidewalls to eliminate any cam-out tendency in either tightening or loosening the fastener. (E-2)

Rate Gyro. New oil-filled rate gyro which incorporates a non-heated temperature sensitive mechanism to maintain a linear damping over the ambient temperature range of —54°C to +71°C, announced by G. M. Giannini & Co., Inc. Model 36129 has a precision potentiometer pickoff which provides rate signals up to 70 volts with linearity of ±1.5% or better and repeatability of ±0.4%. (E-3)

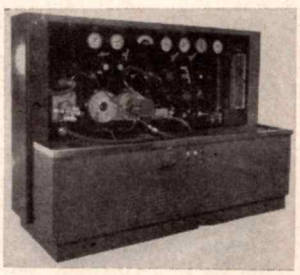


Nylon Grommet. Lightweight strips of nylon eliminate stocking special sizes of grommets for electrical and mechanical protection, according to Nylon Molding Corporation. The grommets, which can be snapped into place where needed, follow the contour of any shapes such as circular, elongated or oval. (E-4)

Computer Tubes. General Electric Tube Department announces development of a 9-pin miniature medium-mu twin triode tube, the 6829, first in a line of 5-Star computer tubes. Company says the 6829 has an altitude rating of 60,000 ft and withstands impact acceleration of 450-g and vibrational acceleration of 2.5-g. Maximum plate voltage is 254 volts. (E-5)

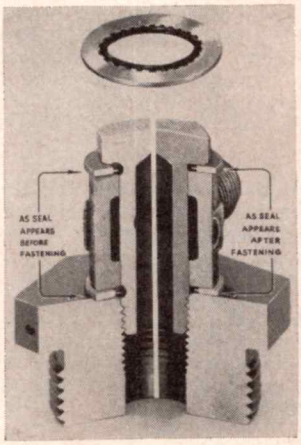
Heat Reflective Laminate. Swedlow Plastics Company has developed a new heat-resistant laminate which embodies characteristics for modern aircraft applications where resistance to elevated temperatures is desirable. By combining the principles of reflectivity of radiant energy with the insulation characteristics of glass fabric reinforced plastic, a product is obtained, the company reports, which affords an efficient barrier to heat transfer at temperatures up to 1200°F. (E-6)

Wire Insulation. New thermocouple wire insulation, said to offer greatly improved resistance to abrasion, solvent and acid resistance to 600°F, and suitable for continuous operation to 900°F in dry atmospheres, announced by Revere Corporation of America. Series of wires using the new insulation are available in various gage sizes to thermocouple and lead wire accuracy. (E-7)



Test Machine. Greer Hydraulics, Inc. announced development of new test machine that performs same course of tests formerly requiring two different machines. Designated model HPM50-2H, machine measures performance of variable displacement pumps and motors up to 75 hp, hydraulic flows from 1.4 to 41 gpm, and pressures to 3500 psi. (E-8)

Clamp. New clamp invented by North American Aviation packaging engineers to replace nails in fastening together cleated panel boxes is claimed to have 30 times the holding power of a nail. Named the Klimp, device is an L-shaped clamp of spring steel that can be used over and over again. Since it does not damage the wood, it permits shippers to use containers many times over. For speedy use, North American engineers have also invented a simple hand tool with a weighted head for tapping on the Klimps and a curved claw for removing them. (E-9)



Sealing Device. The Franklin C. Wolfe Company says it has developed a new sealing device that assures zero leakage of banjo fittings. Called the Banjo-Seal, new sealing development has special configuration of rubber and retainer metal for sealing up to and beyond 5000 psi against air, oil or fuel, and at temperatures from 165°F to +350°F. (E-10)

Maximizer Kit. The Garrett Corporation's AiResearch Aviation Service division is offering as a package installation to owners of DC-3 aircraft a new process of modification and modernization called the Maximizer Kit, which is designed to increase speed, provide substantial and measurable margins of safety at high and low speeds and rate of climb, and also improve payload, economy and revenue with no increase in horsepower. Performance modernization is effected by installation of newly designed, integrated system of engine cowling engine baffles, oil cooler ducting, wheel well doors and exhaust system. (E-11)

Push-Pull Connector. New miniature push-pull connectors that connect and automatically lock by being pushed together, and disconnect by being pulled back, are revealed by The Deutsch Co. Manufacturer says they operate in the direction of plug travel, without twisting or lockwiring, and are well-suited for crowded installations and as umbilical or breakaway units that can be remotely disconnected. (E-12)

Oscillator. Equipped for square-wave or sine-wave modulation from built-in 400-cycle and 1000-cycle sources, new Model 1141 power oscillar has frequency range covered in two, overlapping bands: 200 to 1050 and 950 to 2500 mc/sec. The W. L. Maxson Corporation. (E-13)

Direct Writing Oscillograph. New two-channel, direct-writing oscillograph which provides recordings of frequencies up to 250 cps at one-in. double amplitude has been announced by Consolidated Electrodynamics Corporation. Used with a Type 1-133 amplifier, this equipment can reportedly record voltages from practically any source, including magnetic-tape playback units, carrier amplifiers, audio amplifiers, d-c amplifiers and telemetering discriminators. (E-14)

Power Supply. Electronic d-c to d-c transistorized power supplies that deliver 50 watts from 24 volt input now available from Universal Atomics Corporation. Manufacturer says 2-lb weight and compact size make these units especially suitable for guided missiles, rockets and aircraft. (E-15)

Vertical Drafting Board. L.A.B. Corporation has introduced new vertical drafting board, designed to reduce draftsman fatigue. Board is available in two models, one with fixed board angle of 15° from vertical and the other adjustable through an arc of 85° from vertical. Both models have an up and down adjustment of 20 in., permitting draftsman to work seated or standing. (E-16)

Liquid Spring. New Model 6204 liquid spring using liquid compressibility has been announced by Taylor Devices Incorporated. Spring is ¾ in. in diameter and 2½ in. long plus mounting stud, has a 5/32 in. stroke with an 800 lb preload and an end force of 400 lb. (E-17)

Flexible Coupling. New miniature flexible coupling, especially developed for sub-fractional horsepower motors and other small units, is rated at 1/20 hp at 1750 rpm. Full range is from 0.003 hp at 100 rpm to 0.103 at 3600 rpm. Lovejoy Flexible Coupling Co. (E-18)

Solenoid Valve. New rotary solenoid valve, developed especially for high pressure aircraft hydraulic, pneumatic and fuel systems over a pressure range of 0 to 3000 psi, was designed to handle almost all fluids, including LOX and nitrogen, according to Pneu-Hydro Valve Corporation. Available with ports for ¼, ⅜ or ½ in. diameter tubing. (E-19)

Magnesium-Thorium Sheet. The Dow Chemical Company has announced that its HK31A magnesium-thorium sheet is now available in adequate stocks to make possible immediate delivery for high temperature aircraft development projects. HK31A is the first of a new series of magnesium elevated temperature alloys containing thorium, zirconium and manganese in various combinations. Sheet retains good short-time properties up to 800° F and good long-time properties up to 600° F, according to the Dow Magnesium Department. Sheet is rolled in gages from 0.016 to 2 in. and is furnished in hard-rolled and annealed conditions. (E-20)

Teflon Hose. Aeroquip Corporation has announced availability of Teflon hose with detachable, reusable fittings. Proposed for applications where unusual exposure to wide temperature ranges and injurious chemical action is encountered, Aeroquip says hose is leak proof and can be attached and detached easily with simple hand tools. (E-21)

Potentiometer. New 3 in. diameter single-turn series 5700 Helipot Corporation precision potentiometer is housed in a dimensionally stable one-piece plastic cup and can have 8 sections ganged on a common shaft at the factory—each with a maximum of 33 taps. Other features include standard range of resistance from 50 to 163,000 ohms and linearity as close as ±0.1%, the manufacturer reports. (E-22)

Cockpit Blade Tracker. Small, lightweight device developed by Kaman Aircraft engineers now permits a helicopter pilot to put his ship's rotors "in-track" during flight. Known as cockpit blade tracker, device allows pilot to correct rotor out-of-track conditions without resorting to on-the-ground checking and adjustments of the rotor by a mechanic, it is stated. Cockpit blade tracker consists of a small crank located in the pilot compartment of helicopter. (E-23)

Line Voltage Regulator. All-magnetic a-c line voltage regulator for 400-cycle systems, capable of delivering a sinusoidal output despite a-c input distortions, now available from Magnetic Research Corporation. Time response of the unit, designated Model MXP-3000, is 10 milliseconds for 100% load change. Static regulation is ±0.5 volt from 395 to 405 cps and ±1 volt from 380 to 420 cps. Load may be varied from 0 to 25 amperes without changing the output voltage more than the stated amount. (E-24)

Drafting Pen. A drafting instrument whose ink flow is controlled by capillary action, a product of the West German firm of Clemens Riefler, was recently introduced in this country. Called the Riefler Grafika, the pen uses rubber based, India or colored inks and will draw a continuous line, 1 mm thick, 700 ft without refilling, it is stated. Instrument is said to be capable of producing line thicknesses ranging from .1 mm to 2.8 mm according to the nib selected, and by means of a conical screw device enclosing the upper shaft of nib to further control the width of the line. Available from Quality British Corporation, New York City. (E-25)

Accelerometers. New Massa Laboratories, Inc. standard accelerometers Model M-142B, M-191 and M-198 are stiffness controlled vibrating systems suited for making transient vibration measurements over a wide frequency range of operation. Company reports that units are sensitive only to the vector component of the vibration lying along the axis of the unit. (E-26)

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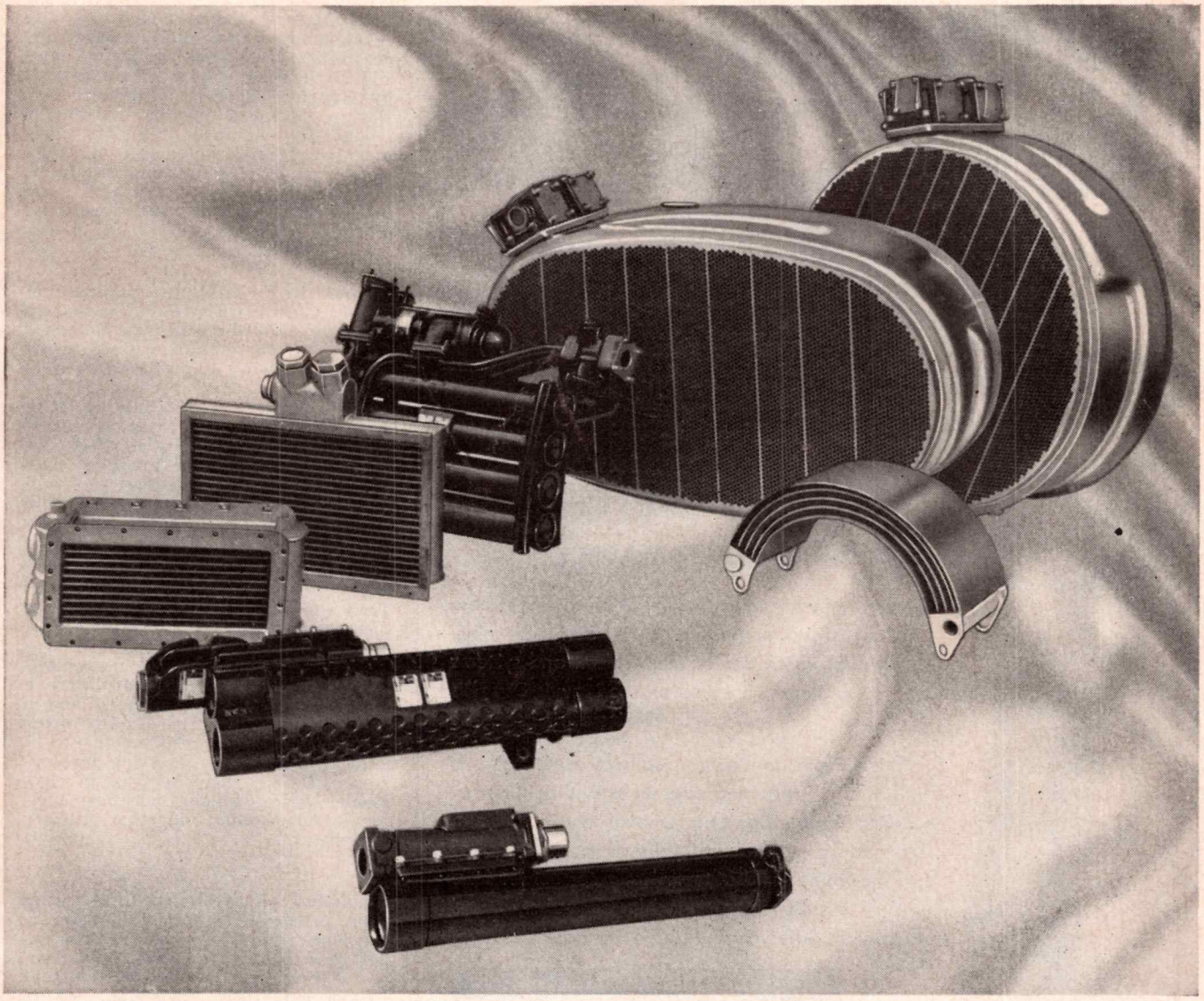

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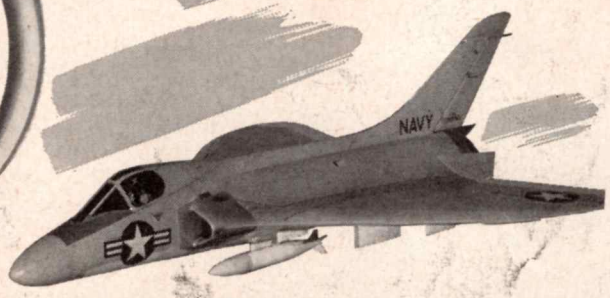

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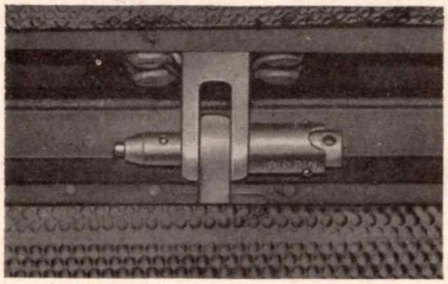

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For further information circle Reader Reply No. 7.

Subminiature Tubes. New line of seven subminiature tubes designed under military contract for guided missile applications has been announced by Sylvania Electric Products, Inc. Design features include a shorter mount for increased rigidity, comparatively wide element spacings which reduce probability of inter-element shorts, and adequate vibrational noise control over a wide vibrational frequency spectrum. (E-27)

Harness Reel. Miniature harness reel recently developed by Pacific Scientific Company is said to provide increased flight comfort and safety for aircraft personnel. 1-lb automatic HR-40 reel works against force tending to hurl user in any direction, locking with split-second timing when occupant moves in excess of 2 g's. Self-contained, eliminating reliance on electrical or hydraulic systems, reel will withstand a minimum load of 4000 lb at any strap extension, according to manufacturer. (E-28)

Transistors. New surface barrier technique for mass production of high-speed and UHF transistors was recently announced by Philco Corporation. Two new types of transistors, a micro-alloy transistor (MAT) and a surface-barrier diffused transistor (SBDT), the direct result of this technique, are now in engineering development. Devices may be used in electronic brains, guided missiles, communications, radar and other military equipment. (E-29)

Irradiated Polyethylene. Plastics parts fabricated from irradiated carbon-black filled polyethylene are being produced experimentally by General Electric's Chemical Development Department at Pittsfield, Mass. Known as Vulkene 107-E vulcanized reinforced polyethylene, new material is a black, tough, flexible plastic with physical properties, heat and chemical resistance reportedly superior to conventional high pressure polyethylene, from which it is derived. Yield strength at low temperature for Vulkene 107-E is said to be double that of polyethylene, and creep deformation is reduced to approximately 10% of the value obtained for polyethylene. At 300° F it retains a tensile strength of 500 psi. (E-30)

Relief Valve. New line of in-line relief valves developed for airborne oil-hydraulic applications now available from Vickers Incorporated. Designed for use in 3000 psi systems having operating temperatures up to 650° F, units are adjustable to deliver at rated flow over the range of 2300 to 3850 psi. (E-37)

Miniature Motor. Featuring a governor controlled planetary gear train with integral filter, new miniature motor can be used in timing units for telemetering, commutator switching and kindred functions. Length of unit, developed by El Ray Motor Company, is 2.912 in. from mounting flange. (E-38)

abstracts

Joseph Weil, George S. Campbell and Margaret S. Diederich, AN ANALYSIS OF ESTIMATED AND EXPERIMENTAL TRANSONIC DOWNWASH CHARACTERISTICS AS AFFECTED BY PLAN FORM AND THICKNESSS FOR WING AND WING-FUSELAGE CONFIGURATIONS. NACA TN 3628, (supersedes RM L52122), April 1956.

This paper presents a summary of the effects of changes in wing plan form and thickness ratio on the downwash characteristics of wing and wing-fuselage configurations in the Mach number range between 0.6 and 1.1. Data obtained by the transonic-bump technique at two tail heights have been compared with theoretical estimations made in the subsonic and supersonic Mach number range.

W. P. Achbach, FORMING OF TITANIUM AND TITANIUM ALLOYS, Titanium Metallurgical Laboratory Report No. 42, Two Volumes, May 1956.

A survey of the airframe industry was made to determine the state of art of forming titanium sheet. Thirteen major forming methods evolved from information obtained by personal visit and discussion and through answers to questionnaires submitted to the airframe industry.

Approximately 20 airframe producers were visited and their forming methods observed and discussed. In addition, some 300 questionnaires, designed on the basis of the information obtained during visits to airframe manufacturers, were submitted to companies directly engaged in forming titanium sheet metal shapes. Also, the literature collected by the Titanium Metallurgical Laboratory information center was reviewed and extracted.

The information obtained from these three sources was organized and assembled for easy reference into this report.

M. E. Deich, FLOW OF GAS THROUGH TURBINE LATTICES, Trans. of Russian book: Technical Gasdynamics, ch. 7, p. 312-420, 1953, NACA TM 1393, May 1956.

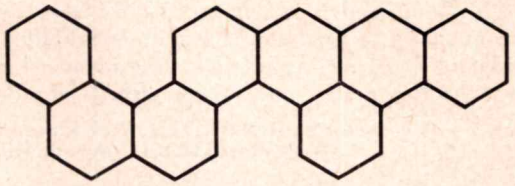
This report is concerned with fluid mechanics of two-dimensional cascades, particularly turbine cascades. Methods of solving the incompressible ideal flow in cascades are presented. The causes and the order of magnitude of the two-dimensional losses at subsonic velocities are discussed. Methods are presented for estimating the flow and losses at high subsonic velocities. Transonic and supersonic flows in lattices are then analyzed. Some three-dimensional features of the flow in turbines are noted.

Eugene S. Love, INVESTIGATIONS AT SUPERSONIC SPEEDS OF 22 TRIANGULAR WINGS REPRESENTING TWO AIRFOIL SECTIONS FOR EACH OF 11 APEX ANGLES, NACA Rept. 1238, (supersedes RM L9D07), 1955.

The results of tests of 22 triangular wings, representing two leading-edge shapes for each of 11 apex angles, at Mach numbers of 1.62, 1.92 and 2.40 are presented and compared with theory. All wings have a common thickness ratio of 8 percent and a common maximum-thickness point at 18 percent chord. Lift, drag and pitching moment are given for all wings at each Mach number. The relation of transition in the boundary layer, shocks on the wing surfaces, and characteristics of the pressure distributions is discussed for several wings.

Thomas C. O'Bryan, Edward C. B. Danforth and J. Ford Johnston, ERROR IN AIRSPEED MEASUREMENT DUE TO THE STATIC-PRESSURE FIELD AHEAD OF AN AIRPLANE AT TRANSONIC SPEEDS, NACA Rept. 1239, (supersedes RM L9C25, RM L 50L28, RM L52A17), February 1956.

Measurements of static-pressure error ahead of sharp-nose bodies, open-nose air inlets, and ahead of the wing tip of a swept-wing fighter airplane model have been made at transonic speeds by use of the NACA wing-flow method.



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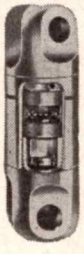

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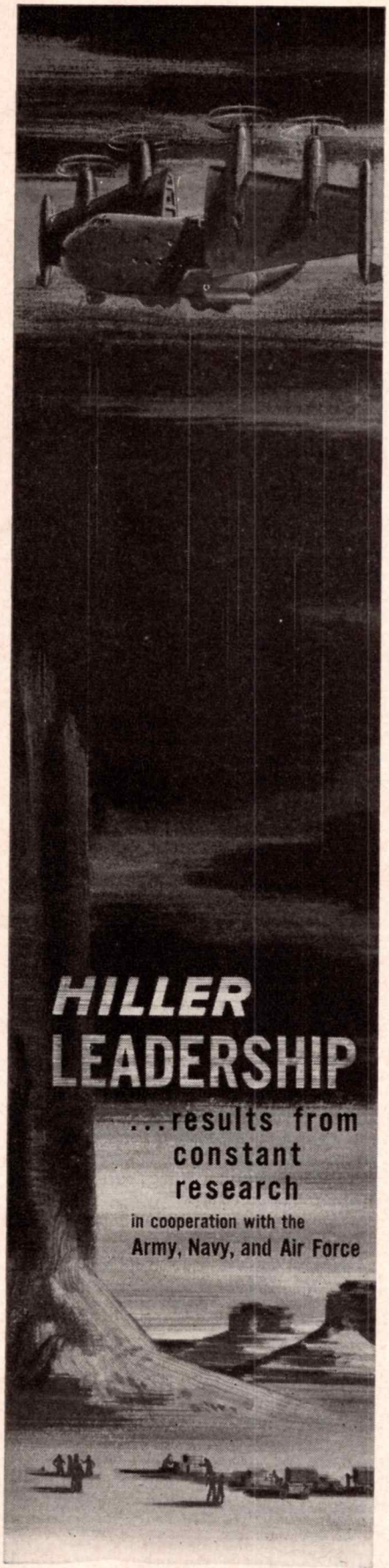

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trade literature

You may obtain copies of booklets and pamphlets below by circling the appropriate number on the Reader Reply Card on page 81.

Aluminum. 176 pp reference handbook compiled by Aluminum Company of America presents data on aluminum alloys and mill products in easy-to-read tabular form. Contains information on alloy standards as well as properties, sizes and tolerances of mill products usually produced from them. Also deals with wrought alloys; sheet and plate; wire, rod, and bar; extrusions; tube and pipe; electrical conductor; structural shapes; forgings, and casting alloys. Includes 140 tables. (T-1)

Electronic Kits. 51 pp Heath Company catalog presents Heathkits for 1956, including test, amateur and hi-fi equipment. Specifications, illustrations and diagrams are included. (T-2)

Ferramic Magnetic Cores. 4 pp bulletin MT-103 gives specifications and data on Ferramic "S-1." Cores are used in digital computer field and have automation and switching applications. General Ceramics Corporation. (T-3)

Power Regulators. 4 pp Sorenson & Company, Inc. brochure gives condensed standard specifications on Company's line of regulation instruments. (T-4)

Impact, Acceleration and Gravity Recorders. 4 pp brochure describes various models of the Impact-O-Graph. Entirely self-contained, units record shocks, impacts and vibrations from any direction. The Impact-O-Graph Corporation. (T-5)

Tubular Products. 4 pp folder TDC-186 is a guide to specifications and applications of tubular products, fittings and flanges in various grades of steel. Tubular Products Division of The Babcock & Wilcox Company. (T-6)

Potentiometer. Data Sheet 54-44 lists specifications, construction, coil characteristics and available modifications on new 1 7/16 in. diameter series 5400 Helipot Corporation precision potentiometer. A single-turn continuous-rotation unit for servo or bushing mounting, the series 5400 is available with or without ball bearings. (T-7)

Multiple-Spline Socket Screws. 6 pp bulletin 723 explains the reasons for use of the multiple-spline method of power transmission in a socket screw and describes applications. Screws are available in both set and cap screw types, in sizes down to #0 wire size (0.060 in.) diameter. The Bristol Company. (T-8)

Printed Circuitry. 16 pp copper clad technical data book explains the principles and some of the problems of printed circuitry. Advices on proper selection of laminates and tells how to make a printed circuit using both the photo engraving and silk screen methods. Also covers plated circuits, plating through holes, flush circuit production and circuit fabricating. Formica Corporation, subsidiary of American Cyanamid. (T-9)

Aluminum. 8 pp bulletin presents guide to selection of flat rolled aluminum, characteristics of rods and bars, specifications for building panels, and obtainable finishes by mechanical and other means. Joseph T. Ryerson & Son, Inc. (T-10)

Fairchild F-27. 6 pp booklet "The Case for the DC-3 Replacement" describes the Fairchild F-27 twin-engine propjet transport. Outlines qualifications of the F-27 as the successor to the DC-3. Powered by two Rolls-Royce propjets geared to 12-foot Rotol propellers, the F-27 can be operated from airports with runways of 3,800 ft, according to Fairchild Engine & Airplane Corp. (T-11)

Magnetic Tape Recording Systems. 7 pp Project Digest No. PD-21 discusses a 3-channel and a 6-channel miniature magnetic tape recording system, developed by Cook Research Laboratories, Division of Cook Electric Company. Although designed and built especially to meet the need for more accurate information on the high-speed operation of both personnel and cargo parachutes, it is claimed these systems are also suitable to the instrumentation of missiles or aircraft where space and weight limitations are severe. (T-12)

Aircraft Fuel Pump. Product Data Sheet No. 3-81 describes Lear, Inc., Lear-Romec Division Model RG-15800 electric motor-driven fuel pump, which supplies smoke fuel for a guided missile tracking system. Fuel is supplied spasmodically, creating a vapor trail from the tail end of missile.

Motor is 0.34 hp at 3000 rpm and 27 volts, dc, with integral radio noise filter. (T-13)

Decimal Equivalent Table. Handy table in form of a ready-to-apply Transeal has been produced by Johnson Research Corp. Transeal is a pressure-sensitive drafting aid for drawings and tracings. Thin, transparent with waxed paper backing, the plastic Transeal is self-adhering and can be printed to any specifications. (T-14)

Scaler. Data sheet No. 38 gives a brief description and specifications on Model 600 nuclear scaler manufactured by The Jacobs Instrument Company. Unit reportedly counts pulses at any repetition rate from 0 to 10 mc and sine waves at any frequency from 10 cps to 10 mc. Manufacturer says 8.5-lb instrument scales by over one million. (T-15)

Flow Control Valves. 4 pp folder presents new line of Quick-Dump flow control valves available from Humphrey Products, a subsidiary of General Gas Light Company. Using a single basic valve body which may be used either normally open or normally closed, valve is adapted for applications up to 125 lb psi and under temperature variations from —40° F to 225° F. (T-16)

Metal Surface Treatments. 47 pp catalog "The Ransohoff Story" presents the various types of machines made by Ransohoff, Inc. for the surface treatment of metal. Includes washing, deburring, cleaning and polishing machines. (T-17)

Loctite Sealant. Technical Reports "Soldering Metal Joints with Loctite Sealant" and "A New Method of Locking Ordinary Fastenings Using Loctite Sealant" describe new product which the manufacturer, The American Sealants Co., claims hardens automatically in the joints between closely fitting metal parts to form a strong heat and oil resistant plastic seal. (T-18)

Electronic Cable. 4 pp bulletin 656, entitled "Electronic CAble as a Systems Component," explains how cable is designed, fabricated, installed and tested to meet system requirements. (T-19)

Chromizing Method. 4 pp folder describes advantages and applications of the Chromalloy process for increasing the heat, wear and corrosion resistance of steel parts by high temperature diffusion of chromium into the surface. This surface alloying by diffusion produces Chromalloy for heat and corrosion resistance and Chromcarb for wear and abrasion resistance. (T-20)

Servo Equipment. 16 pp short form catalog SF 9901 describes the various systems, equipment and components manufactured by Servo Corporation of America. Includes amplifiers, electro-mechanical assembly kits, pyrometers and spectrum signal generator. (T-21)

Special Purpose Receiver. Technical data sheet discusses Nems-Clarke, Inc. Type 1502 receiver for telemetering, guided missile, radiosonde reception applications and as a general purpose laboratory receiver. Operating in the frequency range of 55 to 260 megacycles, the Type 1502 is designed for both FM and AM reception. Use of a type 416-B planar triode in first RF stage assures that the noise figure does not exceed 6 db at any frequency, according to Nems-Clarke. (T-22)

Aluminum. 8 pp technical brochure contains full details on new hollow aluminum bar stock developed by Harvey Aluminum. Discusses tolerances, mechanical properties and applications of the follow machining stock. (T-23)

Electronic Equipment. 356 pp catalog of Allied Radio Corporation lists over 27,000 items, with special emphases on equipment for industrial maintenance, research and production requirements. Includes 39 electronic kits and a technical book section covering theoretical practical aspects of radio, electronics and electricity. (T-24)

Thickness Measurement Instrument. 4 pp folder describes new ultrasonic thickness measuring instrument, the SO-100 Sonizon, manufactured by Magnaflux Corporation. 30-lb unit gives reading of thickness by means of visual cathode tube presentation to ±1% of thickness. (T-25)

Cam Followers and Cam Yoke Rollers. 8 pp bulletin No. 103 gives load and life ratings, as well as specifications for the H C S (High Capacity Stud), the regular type and the new cam yoke roller bearings. Smith Bearing Co. (T-26)

Expansion Joints. 72 pp catalog 56 covers design, manufacture and application of Zallea Brothers' line of packless corrugated expansion joints. Introduces Zallea's new self equalizing, duo equalizing and high pressure toroidal expansion joints. Tables and charts give complete engineering specifications. (T-27)

Printed Circuit Connectors. 12 pp technical brochure covers Electronic Sales Division, DeJur-Amsco Corporation line of printed circuit receptacle for 1/16 in., 3/32 in. and 1/8 in. boards. Includes illustrations, outline drawings and application suggestions. (T-28)

Isolation Efficiency Curve. 4 pp booklet contains a vibration isolation efficiency curve for guidance in the selection of flexible mounting systems for equipment where noise and vibration control is desirable. Lord Manufacturing Company. (T-29)

Machine Tool Motion Pictures. 24 pp booklet lists 123 motion picture films on machine tools and machining operations available from members of the National Machine Tool Builders' Association. Ranging in showing time from 10 to 40 minutes, all films available without charge. With few exceptions, all films are 16 mm. with sound. (T-30)

VHF Receiver. Data sheet describes Model R 5200 AM and FM receiver covering the frequency of 50 to 200 Mc in one continuous band. Can be used to calibrate other receivers, in flight-testing, control tower, propagation studies, monitoring, evaluating transmitters and meteor research. Less than 2 uv is required to produce a 10 db signal-plus-noise to noise ratio, the Servo Corporation of America reports. (T-31)

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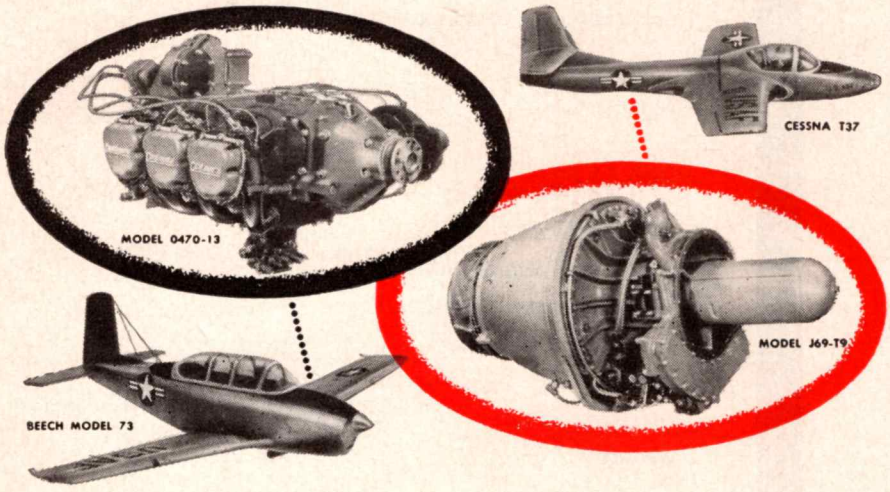

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Aviator's Oxygen Unit. 4 pp brochure discusses Puritan Compressed Gas Corporation's oxygen unit and diagrams installation. Regulator is adjustable to altitude with 3000 lb cylinder pressure gage. Altitude gage is calibrated to 25,000 ft. (T-32)

Couplings. 8 pp catalog No. 62 covers Ajax Flexible Coupling Co., Inc. Series D-100 standard, floating shaft and mill motor type dihedral couplings. Complete working data is given on sizes, capacities and dimensions of Series D-100 couplings designed to handle angular and offset misalignment up to a total of 12°. (T-33)

Flow Meter. 8 pp catalog 10-A-34 illustrates Fischer & Porter Company's line of multi-stage variable-area Flow-rator meters. Designed primarily for aircraft fuel flow testing, instrument provides indication within 0.5% of true flow rate over ranges of from 5 to 100,000 lb/hr according to manufacturer. (T-34)

Relief Valve. 4 pp brochure gives engineering data on Waterman Engineering Company pressure relief valves for airborne equipment. Manufacturer says any special type of configuration can be supplied. (T-35)

Fasteners. 12 pp catalog lists and describes complete range of standard self-locking bolts and screws, set screws, hex nuts, threaded inserts, clinch nuts and cap nuts manufactured by The Nylok Corporation. (T-36)

Plastic Laminate. 4 pp brochure discusses Swedlow Plastics Company's new heat-reflective plastic, which the manufacturer recommends for compartment insulation, valve protection and exhaust heat damping. Includes table of physical and electrical properties of Swedlow silicone laminates. (T-37)

Welding. 56 pp Weldaloy Products Company catalog describes line of resistance welding electrodes, accessories and materials. Gives recommendations and usage of special alloys and electrode materials, applications, specification charts on physical and mechanical properties of Weldaloy alloys and Weldtung copper tungsten alloys. Includes glossary of metallurgical processing and production terms. (T-38)

Blower. 4 pp bulletin B-154A contains selection charts and other engineering data on Standardaire blower, a modern compressor adaptable to either pressure or vacuum service, according to Read Standard Corp. Selection charts give blower model, brake horsepower and rpm needed to provide specified air-moving capacities in cfm at required pressures in psig or vacuums in inches of mercury. (T-39)

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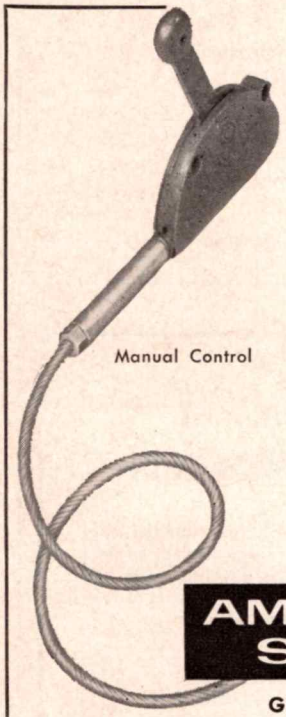

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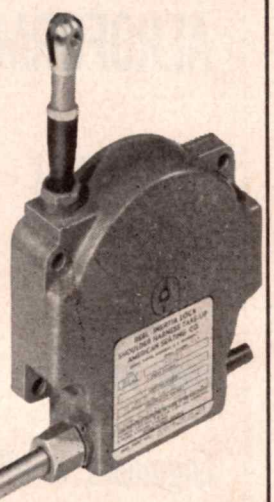

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calendar

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Oct. 23-25 — PREVENTION OF EQUIPMENT DETERIORATION Symposium, U. S. Naval Civil Engineering Research and Evaluation Laboratory, Port Hueneme, California.

Oct. 25-26—Aircraft Electrical Society Annual Display of AIRCRAFT ELECTRICAL EQUIPMENT, Pan-Pacific Auditorium, Los Angeles, California.

Oct. 25-26—2nd Annual Technical Meeting of IRE Professional Group on ELECTRON DEVICES, Shoreham Hotel, Washington, D. C.

Oct. 29-30—3rd Annual East Coast Conference on AERONAUTICAL and NAVIGATIONAL ELECTRONICS, sponsored by Baltimore Section of IRE and IRE Professional Group on Aeronautical and Navigational Electronics, Baltimore, Maryland.

Nov. 1-3—17th Annual Convention of National AVIATION TRADES ASSOCIATION, Hotel Chase, St. Louis, Missouri.

Nov. 8-9—SAE National FUELS and LUBRICANTS Meeting, Mayo Hotel, Tulsa, Oklahoma.

Nov. 13-14—6th TRANSPORT AIRCRAFT HYDRAULIC Conference, sponsored by Vickers, Incorporated, Park Shelton Hotel, Detroit, Michigan.

Nov. 14-15—AIRCRAFT INDUSTRIES ASSOCIATION Export Conference, Miami Beach, Florida.

Nov. 25-27—AVIATION DISTRIBUTORS AND MANUFACTURERS Association, 28th Meeting, Drake Hotel, Chicago, Illinois.

Nov. 26-30—3rd International AUTOMATION EXPOSITION, New York Trade Show Building, New York City.

Nov. 28-30 — International OZONE TECHNOLOGY Conference, sponsored by Armour Research Foundation of Illinois Institute of Technology, Chicago, Illinois.

Dec. 5-7—2nd IRE INSTRUMENTATION Conference, sponsored by Professional Group on Instrumentation and Atlanta Section of IRE, Biltmore Hotel, Atlanta, Georgia.

Dec. 10-12 — Eastern Joint COMPUTER Conference, sponsored by IRE, American Institute of Electrical Engineers and Association for Computing Machinery, Hotel New Yorker, New York City.

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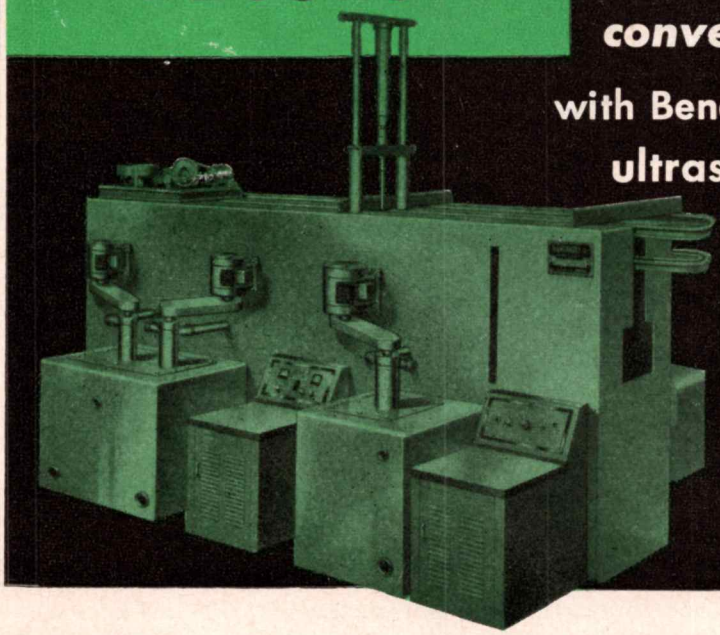

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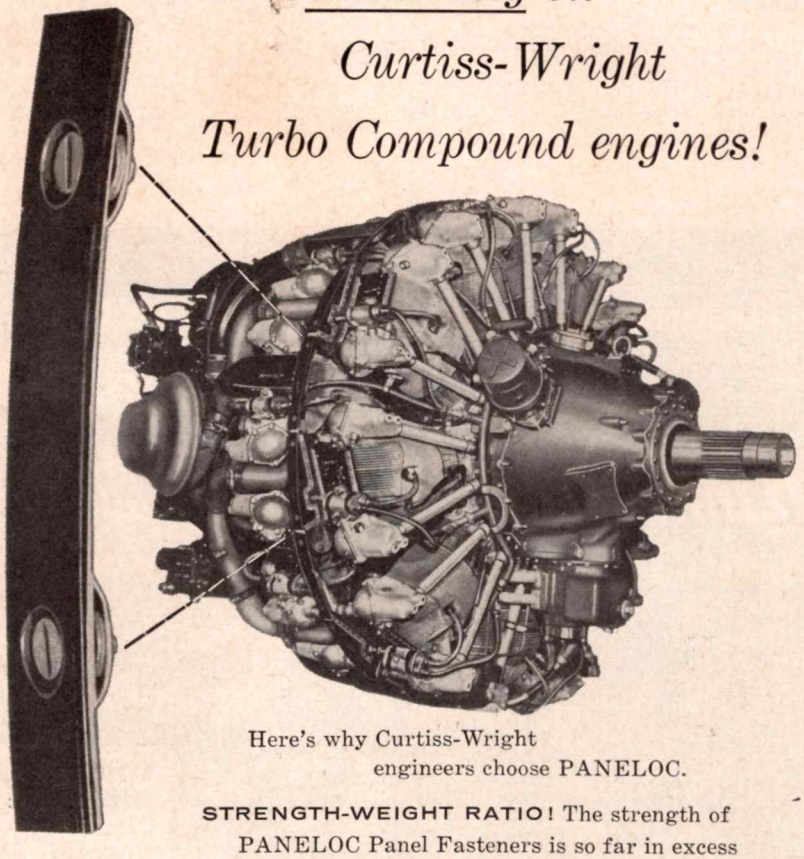

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DISTRICT OF COLUMBIA} ss.:

Before me, a Notary Public in and for the District of Columbia, personally appeared Frederic Hamlin, who, having been duly sworn according to law, deposes and says that he is the Publisher of the AERO DIGEST and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, as amended by the Acts of March 3, 1933, and July 2, 1946, embodied in section 537, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor and business manager are: Editor and Publisher, Frederic Hamlin, 1143 National Press Building, Washington 4, D. C.; Business Manager, None.

2. That the owner is: The Aeronautical Digest Publishing Corporation, 1143 National Press Building, Washington 4, D. C.

3. That the stockholders are: The Lincoln Press, Inc., 1143 National Press Building, Washington 4, D. C.; James C. Galloway, 816 West Fifth Street, Los Angeles, California.

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(Signed) FREDERIC HAMLIN

Sworn to and subscribed before me this 12th day of September, 1956.

(Signed) PAULINE E. GOEBEL,
My commission expires May 15, 1961.

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EDITORIAL

AERO DIGEST

STILL ROOM AT THE TOP

FROM INDUSTRY and military sources come wails of protest that too many self-appointed experts in aerodynamics, electronics and allied fields are lousing up the defense effort. Here today and gone tomorrow, these "experts" wind up bankrupt, uttering matching wails against big business for crowding them out, and against the Pentagon for blindness to talent, enterprise and new ideas.

Both cries of anguish would seem to be fraught with more emotion than good sense. The industry—even the Air Force itself—need not be reminded that all aviation enterprises of any maturity in the country today got their start as small operations and were sparked by some genius who was considered, at least, a non-conformist—though stronger terms were often applied. It may also be worth noting that the persistent and really competent leaders in the history of U. S. aviation development have almost without exception succeeded, despite the swarm of pseudo-geniuses with whom they had to compete and who, too often by useless loud talk, gave aviation designers and engineers a reputation for more derry-doing than sanity.

"As always," to quote one expert who ought to know, "aviation today offers engineering opportunities unequaled by any other industry. Unlike other engineers, those in aviation do not necessarily need a vast plant filled with costly tools to turn their ideas into realities. A drawing board and a slide rule—basic engineering tools—are all that are necessary if a man has an outstanding idea and the courage and persistence to present it competently to the Pentagon. If the idea is good enough, the military will see that it is backed up with the necessary plant and equipment."

Does our man mean that it is easy to sell the Pentagon?

"Emphatically no! The day of the world beating a path to the inventor of a better mouse trap is gone—if it ever existed. It costs time and money to find the right combination of men and to get an idea to the right high command. But this costs not a fraction as much as to start, say, a chemical plant, or to finance a steel mill. And the rewards are high."

Nor are they material rewards, only.

"Aviation still offers golden opportunities to the engineer who cannot stand to be regimented and enjoys working in a small organization that is comparatively free of red tape and puts high premium on getting a job done.

"The challenges from big-company designs and ideas are not insurmountable. Any kind of competition can be met if you have a better product and it is fantastic to suppose that the Pentagon, huge complex operation that it is, will refuse to recognize and finance the best possible equipment for the defense effort."

Who is this authority we have quoted at such length? A banquet orator? A long hair theorist?

On the contrary. He is a man who has just sold a brand new design and idea to the U. S. Air Force as a logical sequel to other original designs of his already being procured by that organization.

His new plane, which hit the news for the first time recently, is the YC-134, featuring Pantobase all-surface landing gear and Boundary Layer control. The plane takes off and lands in less than half the time and distance usually required by conventional aircraft in the 65,000 pound weight class, and can do so from sand, snow, ice, water and rough terrain, as well as from conventional runways.

Its creator, Michael Stroukoff, who designed his own gliders 'way back in 1928, and who since 1943 has pioneered a successful series of combat gliders and troop and cargo transports for the Air Force, has proven again that it's never too late to introduce a new idea, that U. S. aviation can still benefit by small, tightly-knit enterprises—and that, wailings of the critics to the contrary, there is still plenty of room at the top.

—FRED HAMLIN